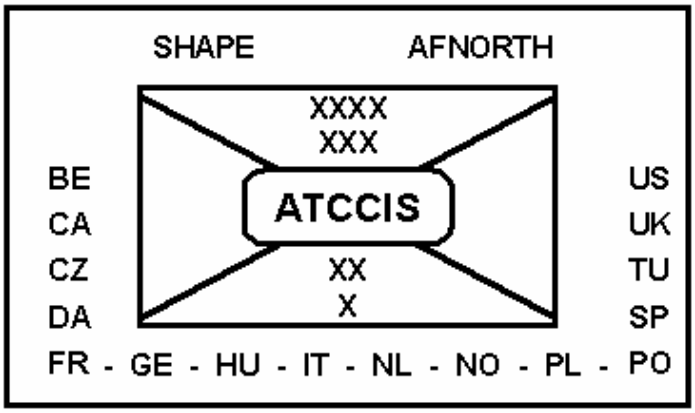
ATCCIS WORKING PAPER 5-7
Edition 5.0

OVERVIEW OF THE LAND C2 INFORMATION EXCHANGE DATA MODEL (LC2IEDM)



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18 March 2002

ARMY TACTICAL COMMAND AND CONTROL INFORMATION SYSTEM WORKING GROUP

SHAPE, BELGIUM

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PREFACE

Introduction

NATO operations require deployed forces to form part of combined and joint coalition formations. Earlier operations focused on general war requirements. Recently NATO forces are increasingly employed in Crisis Response Operations. Both such operations require all participating national units to operate in cooperation with each other. To operate effectively force commanders require a common view of the operational area that is both timely and accurate, and supporting command and control (C2) systems need to pass information within and across national and language boundaries. Moreover, C2 information must be provided to the strategic levels of command including national organisations. Additionally, NATO forces must interact with non-NATO nations, non-governmental bodies, and international and national aid organisations.

The Military Committee approved MC 245 on 18 June 1976, and the North Atlantic Council later noted this on 6 August 1976 (PO/76/87). MC 245 was a statement of the military requirement for interoperability between automated data systems. This visionary statement remains valid today. It led to the start of the ATCCIS programme in 1980.

Army Tactical Command and Control Information System (ATCCIS)

The objective was (and still remains) to see if interoperability can be obtained at reduced cost and developed according to technical standards agreed by Nations and prescribed by NATO. The aim given to the programme was to identify the minimum set of specifications, to be included within C2 systems, to allow interoperability between national C2 systems. The programme has gone through the stages of: operational analysis, technical concepts, proof of concept, transition to operational use, demonstration, and maturing of the specification. The ATCCIS programme is not a formal NATO programme. Rather it is a voluntary and independent activity by the participating nations and is sponsored by SHAPE. The nations and HQs that are active in the ATCCIS programme are: Belgium, Canada, Czech Republic, Denmark, France, Germany, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Spain, Turkey, United Kingdom, United States, Regional Headquarters Allied Forces North Europe (RHQ AFNORTH) and Supreme Headquarters Allied Powers Europe (SHAPE).

The ATCCIS specification is a managed interface between C2 information systems. When incorporated into a system it enables interoperability of information between any other system that also incorporates the specification. Battlespace data is transferred as information. The meaning and context of the information is preserved across national and system boundaries precisely and without any ambiguity.

The information exchange requirements, upon which ATCCIS is founded, encompass the spectrum of Joint and Combined Land Operations. Thus ATCCIS meets the requirements of the Land Component Commander of Allied Joint and Combined Operations (including Article 5 and Crisis Response Operations). Systems may be wholly different from each other and need not necessarily conform to any hardware or software standard.

Typically systems will be acquired through national or NATO acquisition programmes and their architecture will conform to the national or NATO policy prevailing at the time.

In a community of ATCCIS-enabled C2 systems nations, command levels and organisations can share:

- Situational awareness
- Orders, plans and intentions
- Capabilities and status of friendly and enemy forces.

Concept

The ATCCIS specifications consist of two main components: a data model and a replication mechanism. The Land C2 Information Exchange Data Model, LC2IEDM, is the fundamental product. It is a product of the analysis of a wide spectrum of allied information exchange requirements by 16 nations. It models the information that allied land component commanders need to exchange (both vertically and horizontally). It serves as the common interface specification for the exchange of essential battlespace information. The function, implementation and the display of the host C2 application is not the concern of ATCCIS. System developers incorporate the ATCCIS specification and include a single interface to it. Thereafter no further interfaces are required to interoperate with any other ATCCIS enabled system. The LC2IEDM is in its 5th generation (version 5). The previous version, LC2IEDM v2, is the core of the NATO Reference Model and is also a view model of NATO Corporate Data Model (STANAG 5523 / AdatP-32). The LC2IEDM v5 is offered to the NATO Data Administration Group as a revision to the view model.

The ATCCIS Replication Mechanism, the ARM, is complementary to the LC2IEDM data model. When a C2 application changes the state of information that it holds, and which is recognised by the ATCCIS specification, this information is automatically replicated to all other co-operating systems that have agreed to exchange this information. The meaning and context of the information is preserved and requires no additional processing on receipt to make it useful. System managers are able to decide to whom information flows, when and over what communications medium. It should be noted that communication protocols and communication systems are not part of ATCCIS, since the transfer facility employs agreed international standards. Currently, X.400, X.25, and TCP/IP are included within the specification.

The ATCCIS specifications enable interoperability at Degree 3[1] and functions at NATO Level 5 of System Interconnection[2].

ATCCIS Programme

The ATCCIS work has been conducted in programmed "Phases," each with a specific aim:

- **Phase I** (1980-1983) was an initial "Feasibility Study" into the ATCCIS concept.
- **Phase II** (1985-1990) identified the military and technical concepts required to achieve C2 interoperability by the automatic exchange of data.
- **Phase III** (1992-1997) was the "proof of concept" phase. Phase III concluded with a successful demonstration of multinational C2 interoperability between national prototypes for ATCCIS-compliant systems. Interoperability by controlled, automatic data exchange, free of the need for common hardware, software, operating system, or database management system (DBMS) was demonstrated.
- **Phase IV** (1997-1999) concentrated on the refinement of the specifications and transition to operational use. CA, DA, FR, IT, GE, NL, NO, PO, SP, UK, and US were participants in the supporting programme of work. Phase IV included a Command Post Exercise involving nine national ATCCIS-compliant systems. Results from the Command Post Exercise concluded that ATCCIS was a workable solution for C2 interoperability that was achievable using the ATCCIS specifications.
- **Phase V** (2000-2002), known as "ATCCIS 2000," had the aim of completing and maturing the ATCCIS specifications, suitable for building fieldable systems. The programme concentrated on extending the ATCCIS specifications to support "combined joint task forces" and "crisis response operations." Further, the work included developing the necessary procedures to adopt and maintain all ATCCIS components as NATO standards.

Future

The ATCCIS programme merged with the Multilateral Interoperability Programme (MIP) in early 2002. The ATCCIS ethos was passed to the enlarged MIP and MIP has taken the responsibility of keeping and further developing the ATCCIS specifications. The nations and HQs that are active in the enlarged MIP programme are: Australia, Belgium, Canada, Czech Republic, Denmark, France, Germany, Italy, Netherlands, Norway, Poland, Portugal, SHAPE, Spain, Turkey, United Kingdom, and United States. In addition Austria, Hungary, Bulgaria and RHQ AFNORTH are expected to join; and Switzerland, Finland,

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[1] *The NATO Policy for C3 Interoperability* [NC3B Sub-Committee AC/322 SC/2-WP/72 (Revised) Version 4.3]: "Seamless sharing of data that involves the automated sharing of data amongst systems based on a common exchange model."

[2] STANAG 5048 - *The Minimum Scale of Connectivity for Communications and Information Systems for NATO Land Forces* (Edition 5. Promulgated 16 February 2000 by NC3B Sub-Committee AC/322 SC/1). "Two systems which are open to each other, and which conform to minimum standards for information definition and transfer such that there are no fixed constraints on the extent of access by users of one system to the other, but dynamic constraints are applied to each system, in accordance with the current operational situation, such that only a user-defined subset of the total information base of one system is available to the other."

Lithuania, Sweden, NATO Consultation, Command, and Control Agency (NC3A), NATO HQ Consultation, Command, and Control (C3) Staff and NATO Data Administration Organisation Staff have expressed interest.

These nations wish to achieve international interoperability of Command and Control Information Systems (C2IS) at all levels from corps to battalion, or lowest appropriate level, in order to support multinational (including NATO), combined and joint operations and the advancement of digitization in the international arena. The enlarged MIP will build, in an evolutionary way, on the baseline of interoperability already provided by the MIP and ATCCIS products.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 Evolution of the Generic Hub Data Model

1.1.1 General

1.1.1.1 In order to achieve automated information exchange within NATO, a common specification and structuring of the information to be exchanged is required first.

1.1.1.2 The structure of the information is expressed in a data model, built and documented in accordance with an accepted methodology. This model defines the standard elements of information (data) that form the basis for interoperability between those automated NATO national Command and Control Information Systems (C2ISs) that accommodate the model's information structure.

1.1.1.3 Current information exchange requirements (IERs) change over time, and for that reason there was a need to design a flexible generic model that could adapt over time to changing information needs as well as serve as a basis or hub, if nations desired, for new national systems. For these reasons the data model was formally known as the Generic Hub (GH) Data Model. The name was changed to Land C2 Information Exchange Data Model (LC2IEDM) in 1999. Usage by many people is to refer to the model with interchangeable tags *GH* and *LC2*.

1.1.1.4 The extent of requirements agreed by ATCCIS nations is to define only the information that is to be exchanged, rather than model all of the information that would normally be required by a national system. Consequently, LC2IEDM is first and foremost an ***information exchange data model***. The model can also serve as a coherent basis for other information exchange mechanisms currently lacking a unified information structure such as message formats.

1.1.1.5 As a minimum, the NATO nations require the LC2IEDM to preserve the meaning and relationships of the information exchanged and thereby attain the interoperability associated with NATO Level 5 of System Interconnection (automated exchange of data, with user-imposed constraints, between C2IS databases).

1.1.1.6 The structured data specifications for agreements on meaning and relationships of data have two major components that are the subject of LC2IEDM:

a. A data model that specifies agreed data requirements together with their structure in the form of entities, attributes, and relationships; and

b. A physical scheme that specifies agreed metadata.

1.1.2 Fundamental Information Structure/Data Modelling Concepts

1.1.2.1 Trying to create an information structure that represents all of the information contained in the battlespace is an understandably complex task. Data modelling methodologies have adopted several conventions that parallel the military staff processes in many ways. There are three actual models that are presented in LC2IEDM, namely the conceptual, logical and physical.

1.1.2.2 **Conceptual Data Model.** The Conceptual Data Model represents the high level view of the information in terms of generalised concepts such as Actions,

Organisations, Materiel, Personnel, Features, Facilities, Locations and the like. This model is of interest to senior commanders wishing to verify the scope of the information structure. The presentation in Chapter 3 may be viewed as conceptual.

1.1.2.3 **Logical Data Model.** The Logical Data Model represents all of the information and is based upon breaking down (or sub-typing) the high level concepts into information that is regularly used. For example, a tank is an armoured fighting vehicle that is a piece of equipment that is a piece of materiel. This breakdown follows human reasoning patterns and allows command and control systems to generalise by recognising, for instance, that tanks are equipment. A logical data model specifies the way data are structured with an entity-attribute-relationship diagram and supporting documentation. This model should be of interest to staff officers to ensure that the operational information content is complete. Most of the main part of the document as well as a number of annexes focus on logical aspects of the model.

1.1.2.4 **Physical Data Model.** The Physical Data Model provides the detailed specifications that are necessary to generate a physical schema that defines the structure of a database. It is of primary concern to C2IS system developers building LC2IEDM-compliant systems.

1.1.3 The Notion of a Generic Hub Data Model

The data model encompasses the information requirements of several specific functional areas in the domain of land tactical operations. Since the data specific to a functional area may be considered as attached to the common core as "spokes on a wheel," the common-core data model was termed the Battlespace Generic Hub or simply the Generic Hub. Use of the Generic Hub as the basis for functional area models ensures that the data common across all areas is viewed and structured in a standard way and that the data model views can be readily integrated into one coherent structure. The concept of the interdependence of the generic hub and the speciality subjects represented by functional areas is illustrated in Figure 1 below.

1.1.3.3 The initial evolution of the model included specific inputs from the following functional areas: conventional fire support, barrier engineering operations, communications and electronics, and personnel administration. Requirements have been drawn from these as well as other functions, as documented in Chapter 2.

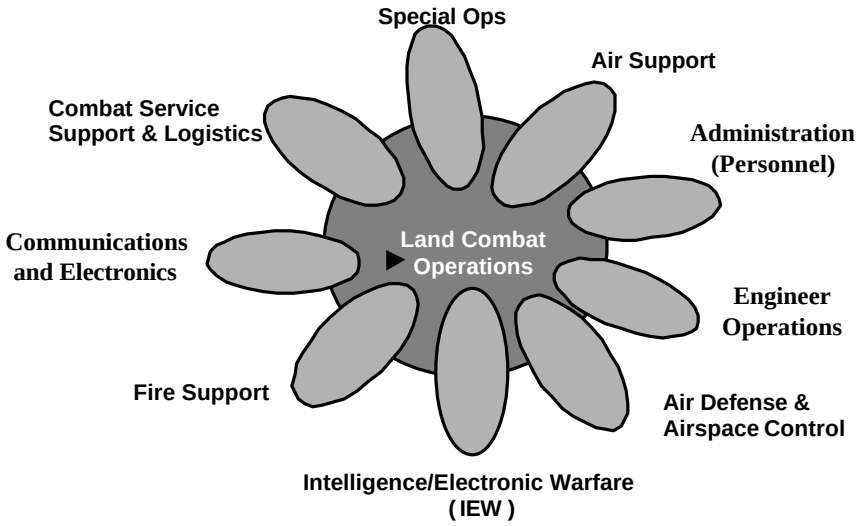

Figure 1. Generic Hub and Its Relationship to Functional Areas

1.2 Purpose of LC2IEDM Documentation

The aim is to provide the following:

a. A description of the common data in an overall model that contains all relevant data abstracted in a well-structured and normalised way, unambiguously reflecting their semantic meaning.

b. A base document that can be used as a reference for future amendments to the model.

c. A core upon which nations can base their own modelling efforts of chosen areas and onto which specialised area models can be attached or "hung."

d. A basic document that nations can use to present and validate functional data model views with their own specialist organisations.

e. A specification of the physical schema required for database implementation.

1.3 Scope

The scope of the analysis carried out in the development of the LC2IEDM is principally directed at producing a corporate view of the data that reflects the multinational information exchange requirements for multiple echelons in land-based wartime operations and crisis response operations (CRO) to include joint interfaces that support land operations. The data model is focused primarily on the information requirements that support the operations planning and execution activities of a military headquarters or a command post.

1.4 Structure of This Document

1.4.1 The organisation of the main body of this paper is summarised as follows:

a. Introduction (Chapter 1).

b. Overview of Requirements (Chapter 2). The overview provides a general statement of requirements that the data specification attempts to meet.

c. Overview of the Conceptual Data Model (Chapter 3). The overview provides a general description of design considerations underlying the data model, a brief description of the model in operational terms, and a summary description of the model concepts in technical terms.

1.4.2 The following annex is provided:

a. Annex A—Entity Level View of LC2IEDM

2. OVERVIEW OF REQUIREMENTS

2.1 Introduction

The purpose of this chapter is to provide an overview of the information exchange requirements that underpin the model.

2.2 General Requirements in ATCCIS Phase III

2.2.1 Modelling work was started early in Phase III (in 1992) without a formal statement of information exchange requirements. The Data Subgroup was staffed by a combination of serving military officers and technical experts and acted as its own source of requirements. The extensive military experience provided a good basis for the initial design. The underlying requirements corresponded in general terms to those outlined in Table 1.

Table 1. Summary of Battlespace Information Requirements

Major Topic	Information Category
Forces (friendly and enemy)	Force composition Force disposition Force sustainment Mobility and transportation Weapons systems C4I and other information systems
Environmental conditions—physical	Land Sea Air Space
Environmental conditions—civil	Political Cultural Economic
Situational information	Mission C3 conditions Intelligence Targeting Deployment, movement, and manoeuvre Protection Sustainment
Operational context	——

2.2.2 Table 2 provides further detail. The requirements should be viewed in the context of applicability for the *international exchange* of information between national C2 elements as well as the potential use of LC2IEDM for exchange of information between C2 elements of *multinational* formations.

Table 2. Categories of Battlespace Information

Information Category	Definition
1. Friendly or Enemy Forces	
1.1 Force Composition	Types and numbers of military and non-military forces.
1.2 Force Disposition	Locations of military forces.
1.3 Force Sustainment	Capabilities for logistical support (supply, maintenance, medical, etc.).
1.4 Mobility and Transportation	Capability for inter- and intra-theatre movement of forces and materiel.
1.5 Weapon Systems	Type, number, capabilities, and limitations of weapon systems.
1.6 C4I and Other Information Systems	Type, number, capabilities, and limitations of C4I and other information processing systems.
2. Environmental Conditions	
2.1 Physical	Factors arising from nature and the physical environment as modified by man. Includes land, sea, air, and space.
2.1.1 Land	General characteristics of natural and man-made terrain and geological features. Includes information on buildings and infra-structure (roads, communications, etc.) appropriate to the mission.
2.1.2 Sea	General characteristics of the ocean surface and subsurface, harbours, and littoral (coastal) waters.
2.1.3 Air	General characteristics of the lower atmosphere, including climate, visibility, and weapon effects on the atmosphere.
2.1.4 Space	General characteristics of the upper reaches of earth's atmosphere.
2.2 Civil	Information about political, cultural, and economic conditions in the areas (hostile, friendly, and neutral) of military interest.
2.2.1 Political	Information relating to the people, their national government, and international and non-government organisations.
2.2.2 Cultural	Information relating to language, customs, laws, and religion.
2.2.3 Economic	Information relating to manpower, materiel, and money.
3. Situational Awareness Information	
3.1 Mission Information	Factors that frame and influence the execution of the mission. Includes instructions and policies; rules of engagement; status of preparations for the mission; description of the theatre; and time constraints.
3.2 Command, Control, and Communications	Command relationships and procedures for effective management of forces and accomplishment of the mission. Includes planning, communications systems connectivity, and interoperability.
3.3 Intelligence	Threat-related information and general information regarding the enemy that affects mission accomplishment. Includes enemy doctrine, probable courses of action, and vulnerabilities.
3.4 Targeting	Information relating to targets. Includes dispersion, camouflage, hardness, identification, mobility, and range from potential attacking forces.
3.5 Deployment, Movement, and Manoeuvre	Status of lines of communication and planning for deployment, movement or manoeuvre.
3.6 Force Security	Information regarding rear area security; and air, maritime, and land superiority.
3.7 Sustainment	Information relating to the sustainment of forces in conducting the mission.
4. Operational Context	
——	Scenarios and missions involved Phases of operation (peace, crisis, war) Stress and threat levels. Organisations and locations affected Operational perspective (national, theatre, tactical).

2.2.3 The Data Subgroup used the above table as general guidance and supplemented it with contributions and suggestions from individual delegates who used various reference documents as sources, including NATO STANAGs and messages, national field manuals and guides for tactical operations, and selected standard operating procedures. A set of general requirements that emerged over a period of time may be described by the following set of statements:

a. Objects of military significance need to be identified. In this context, "objects" refer to physical things including units, equipment, stores, personnel, facilities, geographic features, and also to non-physical concepts such as co-ordination points, lines, and areas. Such objects may already exist and be known; they may also be newly identified or expected in the future.

b. Individual objects must be distinguished from the classes of objects to which they belong. Many objects in the battlespace are of interest primarily in terms of their class or category rather than as an individual object; for example, tanks, armoured brigades, or infantrymen.

c. Objects and their types need to be described with a number of characteristics that are sufficient for supporting command and control tasks. For example, it must be possible to describe the size of a unit, the name of a commanding officer, or the military load classification of a bridge. Such information tends to be dynamic in nature; as new information becomes available other information becomes outdated or nullified.

d. An explicit subset of the requirement in *paragraph c* is the need for information elements associated with objects to permit suitable display of battlespace situation.

e. Selected information about certain characteristics of objects needs to be retained for a period of time. For example, it should be possible to keep a historical log of the location of a unit for purposes of tracking and to specify predicted future locations of a unit for purposes of planning. Such a time record is also needed for other dynamic characteristics of objects, such as their operational or personnel status and their holdings in terms of other objects (e.g., the number of troops and/or equipment in a particular unit).

2.3 Fire Support Requirements

2.3.1 Requirements were also gleaned from specialised functional areas, such as fire support. Fire support is the collective and co-ordinated use of indirect fire weapons, armed aircraft, and other lethal and non-lethal means in support of a battle plan. Conventional fire support includes the employment of field artillery, mortars, naval gunfire (NGF), close-in fire support (employment of rotary wing aircraft in a fire support role), and close air support (employment of fixed wing aircraft in a fire support role).

2.3.2 Fire support consists of three essential parts: command and control, target acquisition for intelligence use, and employment of attack resources. These elements constitute a good description of the more general C2 challenge.

a. Command and control. A large part of C2 activity consists of synchronisation, which is defined as the arrangement of military actions in time, space, and purpose to produce maximum relative combat power at a decisive point.

b. Target acquisition for intelligence use. Target acquisition allows the joint or combined force to detect, identify, and locate targets with sufficient accuracy and timeliness to permit their attack. It is a product of intelligence derived from comparison, corroboration, integration, analysis, and evaluation of information collected by any of the intelligence disciplines such as signals intelligence (SIGINT), human intelligence (HUMINT), and imagery intelligence (IMINT).

c. Employment of attack resources. The following attack resources may be employed in fire support: mortars, cannon (howitzers and guns), rocket and missile launchers, fixed wing aircraft, rotary wing aircraft, naval gunfire, and electronic warfare. The attack

resources can be characterised as lethal or non-lethal. Lethal fire support resources include field artillery and mortars, naval gunfire, and air support. Non-lethal fire support resources include offensive electronic warfare (EW), reflected energy emitters, and smoke and illumination munitions and their delivery systems.

2.3.3 Fire support co-ordination and direction requires intensive C2 activity. Two interrelated functions account for the complexity and intensity of C2 activities. The first involves technical fire direction and is a specialised function. The second function is the overall C2 process for employing fire support assets in joint or combined operations and has a considerable bearing on the overall C2 process.

2.3.4 NATO has moved toward increased use of multinational and joint forces with their inherent mix of combat capabilities and the integration of attack means, both lethal and non-lethal, provided by air, naval, and artillery fire support. Increased joint employment of forces has fostered the development of joint tactics, techniques, and procedures. The impact on fire support C3 and the attendant needs for information exchange have been substantial.

2.3.5 The types of information to be exchanged in multinational and joint fire support operations are exemplified by the following categories:

a. Joint and combined fire support planning, allocation of resources, and commanders' guidance.

b. Enemy and situation data including target identification and location information.

c. Fire support requests, both pre-planned and immediate, and schedule of fires.

d. Friendly force location and scheme of manoeuvre information.

e. Joint terminal control actions as provided by a forward air controller, forward observer, gunfire spot team, or laser designation team.

f. Co-ordination and integration of joint use of lethal and non-lethal assets.

g. Battle damage assessment information of friendly and enemy fires.

h. Ammunition status.

2.4 Requirements in Phase IV

2.4.1 IERs for Phase IV were produced by the newly formed Operational Group at the first meeting[3]. The initial set selected by the Operational Group is listed in Table 3. IERs are grouped according to staff function under column heading “Domain.” The last column in the table corresponds to the tracking number assigned by the Data Group and is used in a subsequent table.

[3] ATCCIS meeting AWG IV-1 in September 1997 at Ede, The Netherlands.

Table 3. Initial Minimum Set of Essential IERs

Domain	Abbreviation	Short title	Source	No
G2	FIRST HOSTILE ACT	First Hostile Act	APP9	16
	INTREP	Intelligence Report	APP9	21
	INTREQ	Intelligence Request	APP9	22
	INTSUM	Intelligence Summary	APP9	23
	LANDINTREP	Land intelligence Report	APP9	25
	ENSITREP	Ennemy situation report	APP9	14
G3	PRESENCE	Presence	APP9	39
	OWNSITREP	Own Land Force Situation report	APP9	37
	ROEREQ	Rule of engagement request	APP9	42
	ROEIMPL	Rule of engagement implementation	APP9	41
	ASSESSREP	Commander's assessment	APP9	6
	NBCCDR	NBC Chemical Downwind Report	APP9	33
	NBCEDR	NBC Effective Downwind Report	APP9	34
	NBC1	NBC 1	APP9	31
	NBC3	NBC 3	APP9	32
	OPO Std 2014	Operational Order	Stanag 2014	
	OPLAN	Operational Plan	Stanag 2014	
	FRAGO	Fragmentary order	APP9	18
G4	LOGSITLAND	Logictic Situation Report Land Forces	APP9	27
	LOGASSESSREP	Logistic Assessrep Report	APP9	26
	CASAVACREQ	Casualty Evacuation request	APP9	8
G1	PERSREP	Personnel report	APP9	38
	MEDASSESSREP	Medical assessment report	APP9	28
	MEDSITREP	Medical Situation report	APP9	29
Fire Support	NNFP.FP	Non-Nuclear Fire Planning. FP	APP9	35
	FMR.FMC	Fire Mission Report. Fire mission Command	APP9	17
	AFU.FUS	Artillery Fire Unit Fire Unit Status	APP9	3
Engineer Support	BARREP	Barrier Report	APP9	7
	OBSREP	Obstacle Report	APP9	36
	DMLORD	Reserved Demolition Order	APP9	13
	SCATMINWARN	Scatterable Minefield Warning	APP9	47
	SCATMINREQ	Scatterable Minefield Request	APP9	46
	SCATMINREP	Scatterable Minefield Report	APP9	45
Air Defence	WCO	Weapons Control Order	APP9	48
	ADREP	Air Defence Report	APP9	2
Air OPS	ACO	Airspace Control Order	APP9	1
	AIRATTACKWARN	Air Attack Warning	APP9	4
	AIRREQ	Air Request	APP9	5
Helicopters	HELLSREP	Helicopter Landing site report	APP9	19
	HELQUEST	Helicopter Request	APP9	20
	JAATMSNO	Joint Air Attack Team Mission Order	APP9	24
G5	CMOSITREP	Civil/military Operation order	APP9	10

Domain	Abbreviation	Short title	Source	No
Elecronic Warfare	MIJIWARNREP	Meaconing,Intrusion,Jammin,Interference Warning Report	APP9	30
	EWRTM	EW Request/Tasking Message	APP9	15
G6	CCISSTAREP	CCIS Status Report	APP9	9
	COMSITREP	Communications situation report	APP9	11
	RFREQREQ	Radio Frequency Request	APP9	40
	RRFREQREQ	Radio Frequency Request	APP9	43

2.4.2 Additional description of the IERs is provided in Table 4 where IER name, abbreviated name, and the source are listed in one row. The purpose of the IER is listed in the next row. This set of IERs is referred to as Article V requirements.

Table 4. Capsule Descriptions of Phase IV IERs

IER Name	Abbreviated Name	Reference
Airspace control order	**ACO**	APP-9/2-5-7
To standardise the method used to provide specific orders for airspace management from a higher command to subordinate units.		
Air Defence Report	**ADREP**	APP-9/2-4-7-2
To standardise the method used to provide a summary of Air Defence (AD) engagements since the last ADREP, and to report the status and availability of AD equipment and ammunition.		
Artillery fire unit. Fire unit status	**AFU.FUS**	APP-9/2-4-6-2
To report , amend or delete a record of ammunition held by a delivery unit for current or planned operations.		
Air attack warning	**AIRATTACKWARN**	APP-9/2-5-1
To standardise the method used to warn of imminent enemy air strikes against friendly forces. It may be used in conjunction with either Global Early Warning (GEW) or Local Early Warning (LEW) messages generated by automated AD systems.		
Air request	**AIRREQ**	APP-9/2-5-4
To standardise the method used to request tactical air support for land or maritime operations.		
Commander's assessment	**ASSESSREP**	APP-9/2-4-1-1
To standardise the method used to advise superior Commanders of the situation/operations in the reporting Commander's area of concern, his assessment of the overall situation, and his intended or recommended actions based on that assessment.		
Friendly obstacle list-barrier report	**BARREP**	APP-9/2-4-8-1
To standardise the method for disseminating information from formation to unit level on friendly obstacles, current and planned, in the own forces barrier plan.		
Casualty Evacuation Request	**CASEVACREQ**	APP-9/2-1-3
To request medical casualty evacuation support for single and multiple evacuation and by whatever means. (Medical operational personnel responsible for planning, ordering and directing medical evacuation will use information in this message to task medical evacuation assets).		
CCIS Status Report	**CCISSTATREP**	APP-9/2-8-6 (A 347)
To standardise the method for providing information concerning the status of Command, Control and Information Systems (CCIS).		
Civil/Military Operations Situation Report	**CMOSITREP**	APP-9/2-10-2
To standardise the method for submitting Civil/Military Operation (CMO) Situation Reports.		

IER Name	Abbreviated Name	Reference
Communications Situation Report	**COMSITREP**	APP-9/2-8-7
To standardise the method for submitting daily communications reports to provide a summary of friendly forces communications and information systems status in support of operations and exercises.		
Reserved demolition order	**DMLORD**	APP-9/2-4-8-8
To standardise the method for disseminating information relating to the execution of a reserved demolition.		
Enemy Land Forces Situation Report	**ENSITREP**	APP-9/2-4-1-3
The method used to report and inform on the Enemy Forces situation, to include: locations, boundaries, status, Order of Battle (ORBAT) and subordination of units / formations.		
EW Requesting/Tasking Message	**EWRTM**	APP-9/2-4-13-6
To standardise the method used by a Joint Force Commander to task Electronic Warfare (EW) assets in support of an operational plan. It is also used by component commanders to request the support of EW resources outside their command.		
First Hostile Action	**FIRST HOSTILE ACT**	APP-9/2-2-6
To rapidly provide SACEUR with information on initial enemy / OPFOR hostile acts in order to enable him to react as early as possible.		
Fire mission report. fire mission command	**FMR.FMC**	APP-9/2-4-6-5
To standardise the method used to transmit a command to check fire, cancel check fire, cease loading, cancel cease loading, and fire ; to transmit ready, rounds complete, and cannot comply to the observer, and to transmit the completion of a fire mission.		
Fragmentary order	**FRAGO**	APP-9/2-4-1-4
To standardise the format for and essential elements of an abbreviated form of an Operation Order for use between commands, formations and units. The FRAGO is intended for use to: a. Issue key sections of an Operation Order before the complete order has been produced b. Provide specific instructions to commanders who do not require the complete Operation Order c. Provide a summary of the complete order to serve as confirmatory notes d. Issue timely changes to existing Operation Orders e. Provide an outline operational directive (Mission Order) for use in fast moving mobile operations.		
Helicopter Landing Site Report	**HELLSREP**	APP-9/2-5-9
To standardise the method used to transmit helicopter landing site reports.		
Helicopter Request	**HELQUEST**	APP-9/2-5-11
To standardise the method used by units to request transport helicopter or utility helicopter support.		
Intelligence Report	**INTREP**	APP-9/2-2-7
To inform SACEUR, ACE commanders and other addressees of essential elements of intelligence information obtained through tactical collection efforts. The INTREP provides timely information regarding events that could have an immediate and significant effect on current or pending planning and operations in peace, time of tension and war.		
Intelligence Request	**INTREQ**	APP-9/2-2-8
To standardise the method by which military authorities and forces of NATO nations and NATO commands request intelligence from each other		

IER Name	Abbreviated Name	Reference
Intelligence Summary	**INTSUM**	APP-9/2-2-10
To inform SACEUR and other addressees periodically on military and related politico / economic intelligence and assessment thereof which give an indication of change in potential OPFOR capabilities, preparedness, or military posture, activities, intentions, objectives and / or courses of action in peace, time of tension and war		
Joint Air Attack Team Mission Order	**JAATMSNO**	APP-9/2-5-14
To standardise the method for providing essential information required in a Joint Air Attack Team (JAAT) Mission Order (Msn O).		
Land Intelligence Report	**LANDINTREP**	APP-9/2-2-11
To inform SACEUR of significant changes in the location, combat effectiveness, and other essential elements of information concerning Non-NATO ground Order of Battle (OOB) formations / Units (land forces including naval infantry).		
Logistic Assessment Report	**LOGASSESSREP**	APP-9/2-6-1-1
To inform superior headquarters of the command's logistics status and to provide an assessment of the overall logistics situation for forces, together with intended or recommended action.		
Logistic Situation Report Land Forces	**LOGSITLAND**	APP-9/2-6-1-6
To standardise the method for providing a superior headquarters with an evaluation of a unit or formation's logistic situation, capability, and deficiencies / surpluses. [Deficiencies / surpluses in logistic holdings may be reported separately by the LOGDEFREP (IER ref APP-9 / 2-6-1-4) or LOGSURPREP (IER ref APP-9 / 2-6-1-7) messages respectively.]		
Medical Assessment Report	**MEDASSESSREP**	APP-9/2-6-2-1
To inform higher formations of the Medical and Health services status and to provide an overall assessment of the Medical and Health services situation for in-place and reinforcing forces, together with any remedial action taken or planned		
Medical Situation Report	**MEDSITREP**	APP-9/2-6-2-2
To inform higher formations of the Medical and Health services situation for friendly forces and, in the case of peace support operations under, e.g. UN mandate authority, supporting civilian agencies and staff. It provides the detailed information which forms the basis of the MEDASSESSREP		
Meaconing, Intrusion, Jamming and Interference Warning Report	**MIJIWARNREP**	APP-9/2-4-13-9
To standardise the method used in times of peace and crisis to warn NATO nations, Commands and Units of hazardous electronic warfare (EW) situations caused by MIJI-incidents of hostile, friendly (inadvertent) or unknown origin.		
Nuclear Biological and Chemical Report 1	**NBC1**	APP-9/2-4-5-5
To standardise the method used to report and inform on NBC events. This report is specifically used to provide the observer's initial report giving basic data on a single nuclear, biological or chemical attack.		
Nuclear Biological and Chemical Report 3	**NBC3**	APP-9/2-4-5-7
To standardise the method used to report and inform on NBC events. This report is specifically used to pass immediate warning of predicted contamination and hazard areas following an NBC attack.		
NBC Chemical Downwind Report	**NBCCDR**	APP-9/2-4-5-2
To standardise the method used to report and inform on NBC events. This report is specifically used to disseminate a forecast of all meteorological data required for the chemical hazard area prediction procedure. It is sent every 6 hours and covers 3 consecutive 2 hour periods.		

IER Name	Abbreviated Name	Reference
NBC Effective Downwind Report	**NBCEDR**	APP-9/2-4-5-3
To standardise the method used to report and inform on NBC events. This report is specifically used to provide the effective down wind data needed for the prediction of fallout areas following a nuclear burst, for either the nearest 6 hours or for a period of more than 6 hours ahead.		
Non nuclear fire planning. fire plan	**NNFP.FP**	APP-9/2-4-6-8
To standardise the message format used to transmit fire plan targets and/or orders in a specified target list, to delete fire plan targets and/or orders from a specified target list in a fire plan or to delete an entire plan.		
Obstacle report	**OBSREP**	APP-9/2-4-8-7
To standardise the method for reporting obstacles up the chain of command.		
Own Land Forces Situation Report	**OWNSITREP**	APP-9/2-4-1-8
To standardise the method used to report and inform on the Own Land Forces situation, to include deployment, status and/or Order of Battle (ORBAT) or Task Organisations (TASKORG) of own and subordinate units/formations, and to report the presence of units/formations/installations not under command.		
Personnel Report	**PERSREP**	APP-9/2-1-5
Provides commanders and staffs with a summary of personnel information by quantities and categories.		
Presence	**PRESENCE**	APP-9/2-4-4-2
To standardise the method for identifying or confirming the presence of units/formations/installations within a particular area. The report is used to keep a commander informed on the deployment of all military units/formations/installations within his area of responsibility which both are and are not under his command.		
Radio Frequency Request	**RFREQREQ**	APP-9/2-8-5
To standardise the method for requesting allocation of radio frequencies other than for radio relay.		
Rule of engagement implementation	**ROEIMPL**	APP-9/2-4-2-3
To standardise the method for formally implementing or cancelling Rules of Engagement (ROE(s)).		
Rule of engagement request	**ROEREQ**	APP-9/2-4-2-2
To standardise the method by which SACEUR requests from the NATO Defence Planning Committee (DPC), and Subordinate Commanders request from SACEUR, authority to implement specific Rules of Engagement (ROE(s)) within his/their command area.		
Radio Relay Frequency Request	**RRFREQREQ**	APP-9/2-8-6
To standardise the method for requesting allocation of radio relay frequencies.		
Scatterable minefield report	**SCATMINREP**	APP-9/2-4-8-11
To standardise the method for disseminating information required for a friendly scatterable minefield report.		
Scatterable minefield request	**SCATMINREQ**	APP-9/2-4-8-12
To standardise the method for disseminating information required for a friendly scatterable minefield request.		
Scatterable minefield warning	**SCATMINWARN**	APP-9/2-4-8-13
To standardise the method for disseminating information required for a friendly scatterable minefield warning.		
Operation order	**OPO**	STANAG 2014
To standardise the format for and essential elements of an Operation Order for use between commands, formations and units.		

IER Name	Abbreviated Name	Reference
Operation Plan	**OPLAN**	STANAG 2014
To standardise the format for and essential elements of an Operation Plan for use between commands, formations and units.		
Weapons Control Order	**WCO**	APP-9/2-4-7-5
To standardise the method used to order a new Air Defence (AD) weapon control status over a specific area(s) for a given period of time.		

2.4.3 Individual IERs from APP-9 cover relatively broad ranges of data since each IER is self-contained as a message. Each IER was parsed by the Data Group into a set of smaller and more manageable pieces that are referred to as Information Content Elements (ICEs) and are stored in the IER/ICE Data Base. Table 5 lists the IERs. The ICE count for each IER is listed in the column "ICE Grand Total." The table provides an accounting of the disposition of requirements. The categories are as follows:

a. Complete—Data identified in the ICE can be represented in the model or is derivable from the model. Derivable means that the underlying data identified by ICE definition can be accommodated within the model specification, but the specific form of information required by the ICE needs to be extracted at the application level.

b. Incomplete—Data identified in the ICE cannot be fully represented in the model; modifications to the model may entail addition of domain values, new attributes or new entities.

c. Clarification Needed—The ICE definition is either ambiguous or contains references to undefined acronyms or abbreviations that cannot be deciphered by the analysts. The category may also include a question about the ICE as a requirement. A further explanation has been requested from the Operational Group before further work is done.

d. Requirement Withdrawn—An initial requirement put forth by the Operational Group has been withdrawn from further consideration.

e. Not Applicable—The type of data identified in the ICE definition is not appropriate for the data model specification. It generally deals with data that applies to the structure or administration of the underlying IER as a formatted message.

ICEs that are categorised as *Not Applicable*" or *Requirement Withdrawn* are subtracted from the grand total. The result is labelled *Requirement Total* and it represents the basis for accounting the degree to which the model satisfies requirements. The basis ICEs then are assessed as *Complete*, *Incomplete*, or *Clarification Needed.* The column *Percentage Completed* expresses the ratio of *Complete* to *Requirement Total*.

Table 5. Article V Requirements and Fulfillment in the Model

No	IER	ICE Grand Total	Not Applicable	Requirement Withdrawn	Requirement Total	Complete	Incomplete	Clarification Needed	Percentage Complete
1	ACO	8			**8**	8			100%

No	IER	ICE Grand Total	Not Applicable	Requirement Withdrawn	Requirement Total	Complete	Incomplete	Clarification Needed	Percentage Complete
2	ADREP	6	1		**5**	5			100%
3	AFU.FUS	28	1	2	**25**	23	2		92%
4	AIRATTACKWARN	1			**1**	1			100%
5	AIRREQ	21	2	1	**18**	15	3		83%
6	ASSESSREP	13			**13**	13			100%
7	BARREP	13	3		**10**	10			100%
8	CASEVACREQ	7			**7**	6	1		86%
9	CCISSTATREP	13	1	2	**10**	8	2		80%
10	CMOSITREP	6			**6**	6			100%
11	COMSITREP	6	1		**5**	5			100%
12	COMMON	12	9		**3**	2	1		67%
13	DMLORD	16	3		**13**	13			100%
14	ENSITREP	24		2	**22**	21	1		95%
15	EWRTM	10	1	5	**4**	4			100%
16	FIRST HOSTILE ACT	8			**8**	7	1		88%
17	FMR.FMC	6	1	3	**2**	2			100%
18	FRAGO	29			**29**	29			100%
19	HELLSREP	22	1		**21**	20	1		95%
20	HELQUEST	11			**11**	10	1		91%
21	INTREP	5	1	3	**1**	1			100%
22	INTREQ	29	2	2	**25**	23	2		92%
23	INTSUM	22	1	2	**19**	19			100%
24	JAATMSNO	31	3		**28**	28			100%
25	LANDINTREP	21		2	**19**	11	1		95%
26	LOGASSESSREP	4			**4**	4			100%
27	LOGSITLAND	10			**10**	10			100%
28	MEDASSESSREP	9		2	**7**	7			100%
29	MEDSITREP	14			**14**	14			100%
30	MIJIWARNREP	7			**7**	7			100%
31	NBC1	19	1	1	**17**	17			100%
32	NBC3	13	1		**12**	12			100%
33	NBCCDR	5	1		**4**	4			100%

No	IER	ICE Grand Total	Not Applicable	Requirement Withdrawn	Requirement Total	Complete	Incomplete	Clarification Needed	Percentage Complete
34	NBCEDR	4	1		**3**	3			100%
35	NNFP.FP	31	3	4	**24**	23	1		96%
36	OBSREP	12	2		**10**	10			100%
37	OWNSITREP	23			**23**	23			100%
38	PERSREP	4			**4**	4			100%
39	PRESENCE	8		2	**6**	6			100%
40	RFREQREQ	14			**14**	6	2	6	43%
41	ROEIMPL	10	2		**8**	8			100%
42	ROEREQ	7			**7**	7			100%
43	RRFREQREQ	10			**10**	10			100%
44	SCATMINREC	16	2		**14**	14			100%
45	SCATMINREP	13	2		**11**	11			100%
46	SCATMINREQ	18	2		**16**	16			100%
47	SCATMINWARN	13	2		**11**	11			100%
48	WCO	8			**8**	8			100%
	Grand Total	**640**	**50**	**33**	**557**	**532**	**19**	**6**	**95%**

2.5 Requirements during ATCCIS 2000 (Phase V)

2.5.1 Work on Article V requirements continued during Phase V. In addition, the Operational Group issued an additional set of requirements at first referred to as Peacetime Support Operations (PSO), later changed to Military Operations Other Than War (MOOTW)[4]. The latter usage prevailed throughout the phase; however, near the end of the phase NATO adopted the expression Crisis Response Operations (CRO) in lieu of MOOTW.

2.5.2 CRO requirements are listed in Table 6 to indicate the general categories that are covered. Detailed elements are not shown because they are stored in an Access database and are difficult to summarise except in the form shown here. The Operational Group drew upon multiple sources to produce a set that is unique to the ATCCIS programme and is not documented elsewhere. The categories are the same as for Phase IV; no adjustment is needed to the *ICE Grand Total* in this case since there are no ICEs that were withdrawn or did not apply.

[4] Requirements were issued during AWG 2000-2 in September 2000 in Lisbon.

Table 6. CRO Requirements and Fulfillment in the Model

No	IER	ICE Grand Total	Complete	Incomplete	Clarification Needed	Percentage Complete
1	Arrest Report	11	11			100%
2	Border Crossing	22	22			100%
3	Camps	26	17	8	1	65%
4	Civil Military Operations	47	46		1	98%
5	Confiscated Equipment	44	42	2		95%
6	EOD Incident	28	27		1	96%
7	Holdings Parties	37	35	2		95%
8	Host Nation Support	13	13			100%
9	Incident Report	183	163	17	3	89%
10	Mass Graves	16	16			100%
11	Meteorology	22	22			100%
12	Personnel Identification	36	34	2		94%
13	PSYOPS	24	22	2		92%
14	Refugees and Displaced Persons	9	9			100%
	Grand Total	**518**	**479**	**33**	**6**	**92%**

2.5.2 In recognition of changing realities of potential NATO military operations, ATCCIS Heads of Delegation enlarged the scope in Phase V by adding requirements for joint interfaces that are needed to support land operations. Formal requirements were issued[5] by the Operational Group and are listed in Table 7. The requirements are stored in the same database form as was the case for CRO. The table accounts for the ICEs in the same way as the previous table.

[5] Requirements were made available during AWG 2000-4 in March 2001 in Oslo.

Table 7. Joint Requirements and Fulfillment in the Model

No	IER	Grand Total	Complete	Incomplete	Clarification Needed	Percentage Complete
1	Airfield zone	8	8			100%
2	Aviation areas	6	6			100%
3	Aviation route	10	10			100%
4	Command and Control-Weapon points	5	5			100%
5	Coordination Altitude	5	5			100%
6	Forward Arming and Resupply Point	6	6			100%
7	Maritime Operational Graphics	5	5			100%
8	Close Air Support Resources	7	7			100%
9	Close Air Support Status	5	5			100%
10	Naval Gun Fire Resources	7	7			100%
11	Naval Gun Fire Status	5	5			100%
12	Airfield Facility	15	14	1		93%
13	Air Plan - Airspace Control Order	62	56	6		90%
14	Air Plan - Air Tasking Order	28	28			100%
15	Harbour Facility	8	5	3		63%
16	Order of Battle AIR	15	15			100%
17	Order of Battle SEA	16	15		1	94%
18	Unit Tactical Summary	9	9			100%
	Grand Total	**222**	**211**	**10**	**1**	**95%**

3. OVERVIEW OF THE DATA MODEL

The overview presents principal features of the data structure that has been evolved to satisfy operational requirements. The primary goal is to indicate the scope of the model in covering information categories of interest to the operational user. Examples and explanations attempt to use operational language as much as possible.

3.1 Introduction

3.1.1 Navigation around the model is easier if the architectural basis for it is understood. The model was designed to achieve two separate but related goals. One goal is to describe the objects in the battlespace. This includes characteristics of the objects themselves, their status, their locations, their interrelationships, capabilities, addresses, and other properties. The second goal is to describe activity on the battlefield. This encompasses operational plans and orders, reports of current activity, and predictions or anticipation of future activity. Both goals are important for maintaining situational awareness in support of C2 processes.

3.1.2 The most basic concept in data modelling is an entity, i.e., any distinguishable person, place, thing, event, or concept about which information is to be kept. Properties or characteristics of an entity are referred to as attributes. The attributes make explicit the data that are to be recorded for each concept of interest. [6] This edition of the model contains 194 entities. The entire structure is generated from 12 independent entities, that is, entities whose identification does not depend on any other entity. All other entities are dependent entities.

3.1.3 Independent entities are listed and defined in Table 8. The general role that each entity serves in the model is also evoked. Nine of these entities are considered to be key. They are of fundamental importance in generating the structure of the data model. Collectively, they account for 77% of the model. The other 3 independent entities together generate only 3% of the model. The remaining 20% of the model consists of associative entities that interconnect different parts of the model. While the preceding statements refer largely to the quantitative aspects and do not address the functional significance, even a single entity can be of crucial importance if it satisfies an operational need.

[6] A summary of IDEF1X methodology and notation appears in Annex K.

Table 8. Twelve Independent Entities and Their Roles

Entity Name[7]	Entity Definition	Role in the Model
ACTION	An activity, or the occurrence of an activity, that may utilise resources and may be focused against an objective. Examples are operation order, operation plan, movement order, movement plan, fire order, fire plan, fire mission, close air support mission, logistics request, event (e.g., incoming unknown aircraft), or incident (e.g., enemy attack).	Dynamics (How, what, when something is to be done, is being done, or has been done.)
CANDIDATE-TARGET-LIST	A list of selected battlespace objects or types that have potential value for destruction or exploitation, nominated by competent authority for consideration in planning battlespace activities.	Information to support ACTION.
CAPABILITY	The potential ability to do work, perform a function or mission, achieve an objective, or provide a service.	Indication of expected capability for types and actual capability for items
CONTEXT	A reference to one or more REPORTING-DATAs.	Packaging of information.
LOCATION	A specification of position and geometry with respect to a specified horizontal frame of reference and a vertical distance measured from a specified datum. Examples are point, sequence of points, polygonal line, circle, rectangle, ellipse, fan area, polygonal area, sphere, block of space, and cone. LOCATION specifies both location and dimensionality.	Geopositioning of objects and creation of shapes (Where)
OBJECT-ITEM	An individually identified object that has military significance. Examples are a specific person, a specific item of materiel, a specific geographic feature, a specific co-ordination measure, or a specific unit.	Identifying individual things. (Who and What)
OBJECT-TYPE	An individually identified class of objects that has military significance. Examples are a type of person (e.g., by rank), a type of materiel (e.g., self-propelled howitzer), a type of facility (e.g., airfield), a type of feature (e.g., restricted fire area), or a type of organisation (e.g., armoured division).	Identifying classes of things. (Who and What)
REPORTING-DATA	The specification of source, quality and timing that applies to reported data.	Support for the reporting function.
RULE-OF-ENGAGEMENT	A specification of mandatory guidance for the way a given activity is to be executed.	Support to ACTION.
COORDINATE-SYTEM	A rectangular frame of reference defined by an origin, x and y axes in the horizontal plane, and a z-axis. The vertical z-axis is normal to the xy-plane with positive direction determined from the right-hand rule when the x-axis is rotated toward the y-axis.	Support to LOCATION for specifying relative geometry.
REFERENCE	An allusion to a source of information that may have military significance.	Pointing to external information in support of REPORTING-DATA.
VERTICAL-DISTANCE	A specification of the altitude or height of a point or a level as measured with respect to a specified reference datum in the direction normal to the plane that is tangent to the WGS84 ellipsoid of revolution.	Support to LOCATION in specifying elevation.

Note: The first nine entities are considered to be the Key entities

3.1.4 Key entities and their relationships are illustrated in Figure 2. A dot at the end of a relationship line denotes "many." The relationships shown in this diagram are all many to many. For example, the relationship between OBJECT-ITEM and LOCATION is to be interpreted as a pair of statements that an OBECT-ITEM may have zero, one, or more LOCATIONs and that a LOCATION may apply to zero, one, or more OBJECT-ITEMs. Some of the relationships are recursive, such as those relating ACTION to itself. The IDEF1X standard permits this type of general statement only at a conceptual level in explanatory diagrams such as this one. A fully developed data model must replace the

[7] The convention is to annotate the names of entities in capital letters and separate words by hyphens. If the name of an entity is used in plural, then a lower-case "s" is appended to the name without changing the name (e.g., the plural of CAPABILITY is written CAPABILITYs).

many-to-many relationships with the appropriate structures that admit only *one*-to-many relationships. The resolution of many-to-many relationships can lead to complex structures; the balance of the paper describes the result for LC2IEDM.

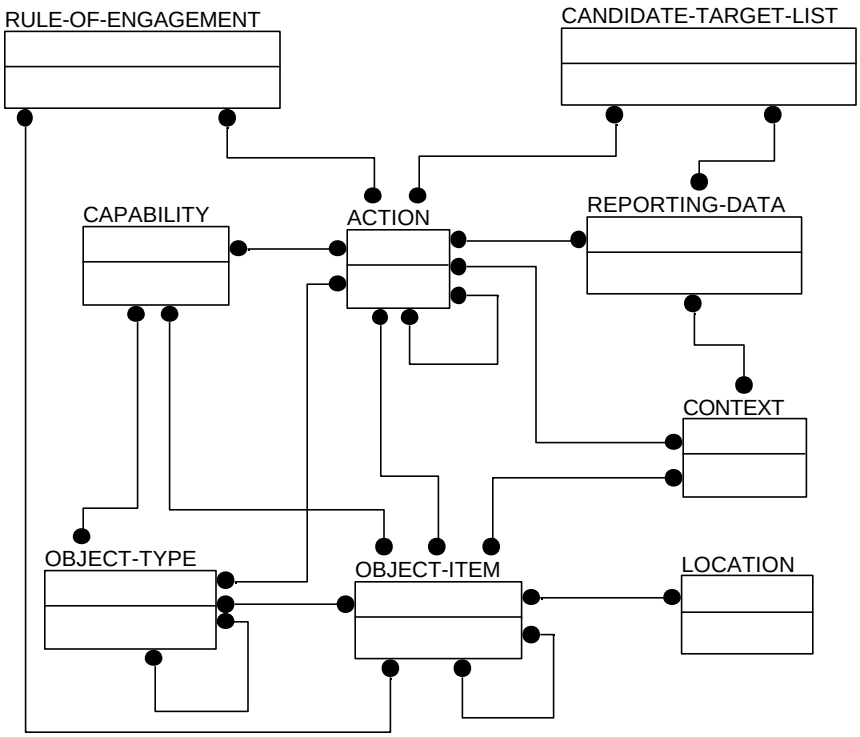

Figure 2. Key Entities of the Generic Hub Data Model

3.1.5 All model explanations in this chapter are presented at the *entity* level as is the case in the preceding figure. WP 5-5 Edition 5.0 contains detailed specifications of the fully *attributed* data model. A brief section summarises the basic concepts underlying the data model before a dissection of the model is taken up in earnest.

3.2 Concepts Underlying the Data Model

3.2.1 LC2IEDM is intended to represent the core of the data identified for exchange across multiple functional areas and multiple views of the requirements. Toward that end, it lays down a common approach to describing the information to be exchanged in a command and control (C2) environment.

a. The structure is designed to be sufficiently generic to accommodate joint, land, sea, and air environment concerns. Currently, the model addresses primarily land operations and some joint interfaces.

b. The data model describes all objects of interest in the battlespace, e.g., organisations, persons, equipment, facilities, geographic features, weather phenomena, and military control measures such as boundaries.

c. Battlespace objects are generically typed and described in accordance with a military taxonomy and specifically addressed as an ***item***. All battlespace *items* must be

classified as being of some *type* (e.g. Tank Call Sign T14C is an item of type "Challenger").

d. An object must have the capability to perform a function or to achieve an end. Thus, a description of capability is needed to give meaning to the value of objects in the battlespace.

e. It should be possible to assign a location to any item in the battlespace. In addition, various geometric shapes need to be represented in order to allow a commander to plan, direct, and monitor operations. Examples include boundaries, corridors, restricted areas, minefields, and any other control measures or symbology needed by commanders and their staffs.

f. The status of items needs to be maintained.

g. The planned assignment of resources by type to a type of battlespace objects is described as an establishment. These establishments are currently described as tables of organisations, equipment, or personnel, are basically fixed (e.g. standard Canadian Light Infantry Battalion) and must be represented in the model.

h. The actual assignment of resources by type to a specific battlespace item is described as a holding (for example the holding of 1e Battalion Les Voltigeurs). The model must reflect information such as the composition of an organisation in terms of subordinate organisation types, equipment types, and personnel types.

i. There is a need to record relationships between specific battlespace items. Key among these is the specification of command relationships in permanent or temporary organisational and task structures.

j. The model must support the specification of current, past, and future employment of battlespace items or types.

k. The data for all battlespace objects, whether friendly or hostile, should be recorded in the same data structure.

l. Provision must be made for the identification of reporting organisations, the effective and reporting times, and an indication of the validity of the data.

3.2.2 Use of free text is to be avoided as much as possible, since there cannot be an agreed understanding of the contents.

3.2.3 Some of the important rules for managing information in the battlespace cannot be represented in a data model, reliance needs to be placed on textual supplements, often referred to as “business rules.”

3.2.4 ATCCIS policy has been to specify the **minimum set of data to be exchanged**. The nations are free to expand their own data structures to cater to additional data representations.

3.3 Identifying “Things” in the Battlespace

3.3.1 “Things” must be identified as the first step: who are the actors and what things are available to or are used by the actors. Model design encompasses two categories of objects: those that can be identified individually (by name—*2 (SP) Armoured Cavalry Brigade*, *Jubilation T. Cornpone*, by call sign or serial number or license plate or passport number, and so on) and those that represent grouped or class properties (a tank, an M1 tank, an M1A2 tank, a helicopter, a howitzer, a rifle, an armoured brigade, a light infantry

battalion, an infantryman). The two categories are used in parallel as basic structural elements of the model. The two structures are related to each other. Data characteristics are entered either on the item side or the type side as appropriate. Any characteristics described on the type side also apply to the item once the item is assigned a type classification. This linkage between item and type is also a model requirement.

3.3.2 LC2IEDM structure labels class objects as OBJECT-TYPE and individually identified instances as OBJECT-ITEM. Implicit in the distinction between type and item is the assumption that data relating to OBJECT-TYPEs will tend to be *static* (i.e., the values of the attributes are not likely to change very often over time), whereas the values of attributes of OBJECT-ITEMs are likely to be more *dynamic*. For example, if a characteristic is about a type (e.g., M1A1 Abrams Tank), it is an attribute of OBJECT-TYPE. Thus, calibre of main gun, track width, and load class are characteristics of OBJECT-TYPE. However, the call sign, actual fuel level, munitions holdings, and current operational status of a specific tank are characteristics of an OBJECT-ITEM. Yet, a mandatory relationship between the two entities enables each OBJECT-ITEM to be classified as an OBJECT-TYPE, thereby *inheriting* characteristics of the type.

3.3.3 Item and type objects are subdivided into extensive hierarchies. The first-level hierarchy is parallel and is illustrated in Figure 3. There are five categories or *subtypes* to encompass any object within the scope of the model: facility, feature, materiel, organisation, and person. A subtype is the same thing as its parent, but it has some properties that do not apply to its siblings. A circle with two lines underneath it is a symbol for complete subtyping.[8] It means that no other category is needed in response to the set of requirements that governed evolution of the model. Definitions of subtype entities are presented in Table 9. As may be expected, the two sets of definitions are similar.

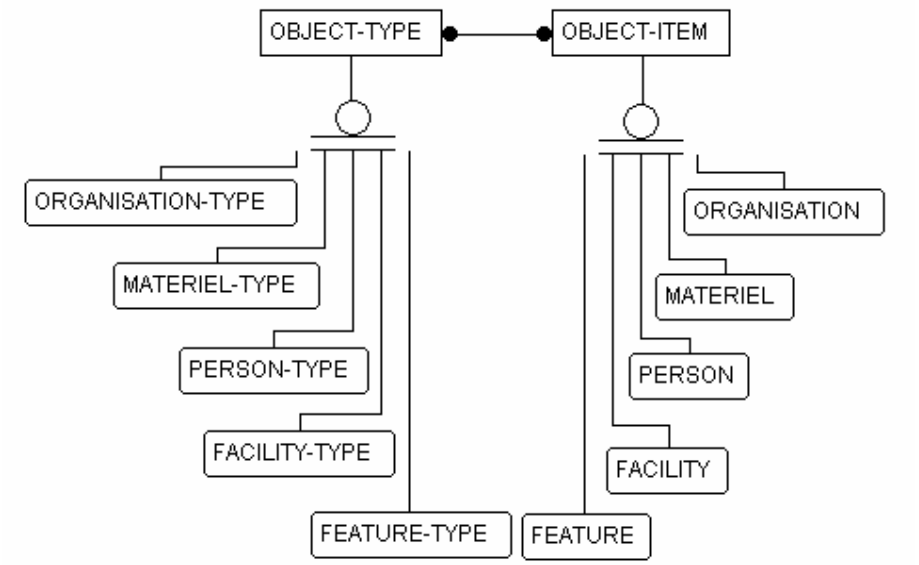

Figure 3. First Level Subtyping of OBJECT-TYPE and OBJECT-ITEM

[8] Incomplete subtyping is denoted by a single line that is drawn under the circle.

3.3.4 Next two sections present the structure of types and items in turn. Entire categorisation hierarchies are presented and discussed. Other structures that are associated with either type or item are also described. Major relationships that connect types and items are discussed in subsequent sections.

Table 9. Definition of First-Level Subtypes

Entity	Entity Definition
FACILITY	An OBJECT-ITEM that is built, installed, or established to serve some particular purpose and is identified by the service it provides rather than by its content.
FACILITY-TYPE	An OBJECT-TYPE that is intended to be built, installed or established to serve some particular purpose and is identified by the service it is intended to provide rather than by its content. Examples include a refuelling point, a field hospital, a command post.
FEATURE	An OBJECT-ITEM that encompasses meteorological, geographic, and control features of military significance.
FEATURE-TYPE	An OBJECT-TYPE that encompasses meteorological, geographic, and control features of military significance. Examples include a forest, an area of rain, a river, an area of responsibility.
MATERIEL	An OBJECT-ITEM that is equipment, apparatus or supplies without distinction as to its application for administrative or combat purposes.
MATERIEL-TYPE	An OBJECT-TYPE that represents equipment, apparatus or supplies of military interest without distinction to its application for administrative or combat purposes. Examples include ships, tanks, self-propelled weapons, aircraft, etc., and related spares, repair parts, and support equipment, but excluding real property, installations, and utilities.
ORGANISATION	An OBJECT-ITEM that is an administrative or functional structure.
ORGANISATION-TYPE	An OBJECT-TYPE that represents administrative or functional structures.
PERSON	An OBJECT-ITEM that is a human being to whom military significance is attached.
PERSON-TYPE	An OBJECT-TYPE that represents human beings about whom information is to be held.

3.4 OBJECT-TYPE Structures

This section presents the details of the subtyping hierarchy for OBJECT-TYPE and a form of type-to-type recursive relationship that has been labelled *Establishment*.

3.4.1 OBJECT-TYPE Subtype Hierarchy

3.4.1.1 The OBJECT-TYPE subtyping tree is extended beyond the first level as illustrated in Figure 4. FACILITY-TYPE has only BRIDGE-TYPE as a subtype, FEATURE-TYPE has two subtypes, MATERIEL-TYPE and ORGANISATION-TYPE have extensive subtype hierarchies; and PERSON-TYPE has no subtypes. Categorisation of OBJECT-TYPE can be done in different ways. There is no right or wrong way. The structure described in the figure happens to satisfy the stated information exchange requirements most closely.

3.4.1.2 Most of the categories are reasonably self-explanatory with the possible exception of GROUP-ORGANISATION-TYPE, CIVILIAN-POST-TYPE, and MILITARY-POST-TYPE. GROUP-ORGANISATION-TYPE was created in response to MOOTW requirements that put forward a need to deal with groups that were not truly organisations but had to be treated as a collective object for data purposes. Consequently, groups of people such as refugees and prisoners of war are treated as pseudo-organisations. Post type is a type of position that is filled by a single individual, such as commander of a military

unit or a police department. It enables a distinction between the duties inherent in a position and the person that fills that position.

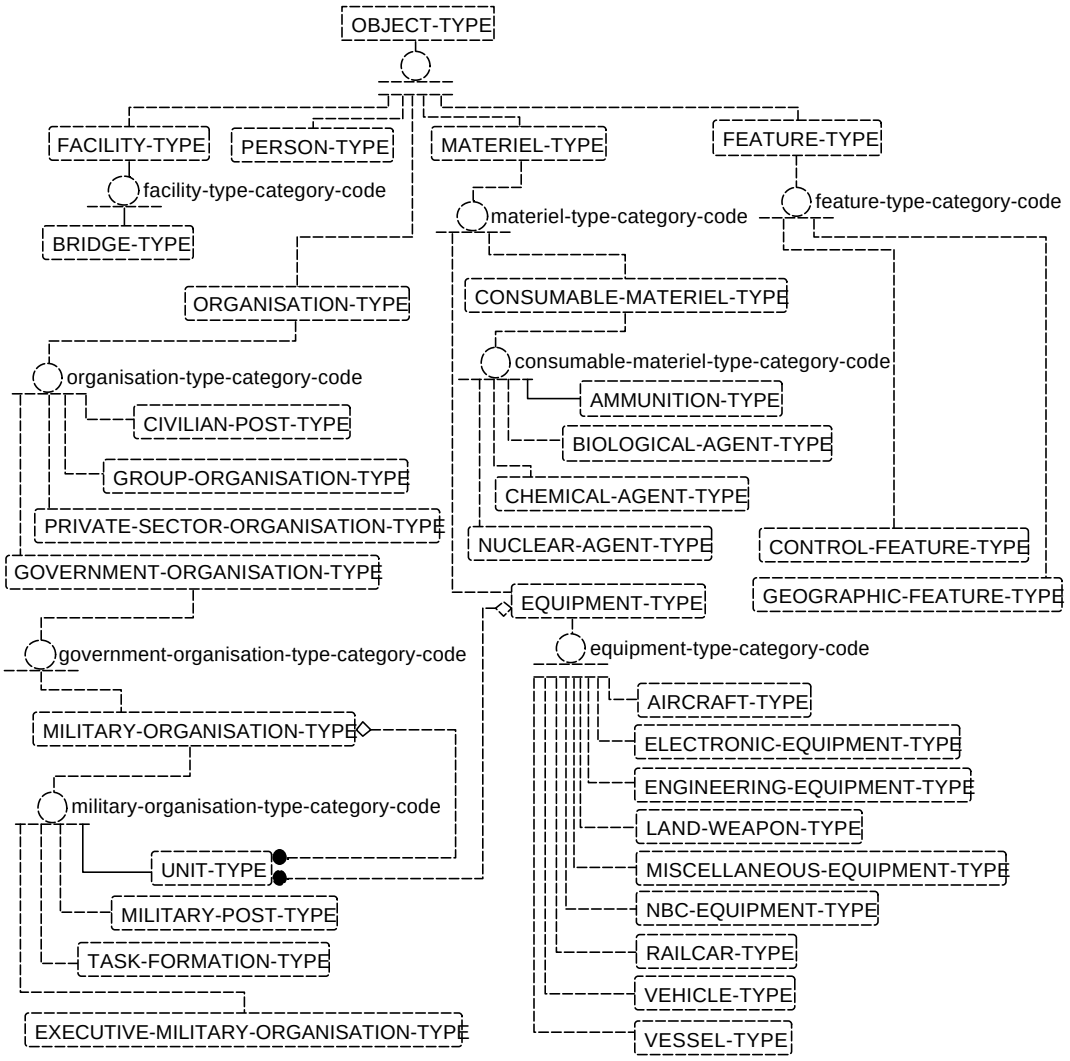

Figure 4. OBJECT-TYPE Subtype Tree

3.4.1.3 The figure displays two non-identifying relationships (dashed lines) with a diamond at one end and a dot at the other. A Diamond indicates that the relationship is optional. No data need to be passed from one entity to the other. A Dot has the same meaning as cited earlier—it is the *many* end of a one-to-many relationship. The relationship from EQUIPMENT-TYPE to UNIT-TYPE allows the identification of the major type of equipment that can be associated with a unit, e.g., Leopard III Main Battle Tank is the major equipment for a tank battalion. The relationship from UNIT-TYPE to MILITARY-ORGANISATION-TYPE permits a refinement in specifying headquarters units. For example, a headquarters company may be designed to serve a division or a brigade. This relationship enables an explicit association that states that an instance of a type headquarters company is intended to serve as the headquarters element of a type division.

3.4.2 OBJECT-TYPE Establishments

3.4.2.1 The recursive relationship shown previously for OBJECT-TYPE is resolved through a structure that consists of relationships among subtypes of OBJECT-TYPE and is referred to as "establishment." "Establishment" consists of the OBJECT-TYPEs that an OBJECT-TYPE is intended or authorised to have, e.g., the tables of organisation and equipment for a unit type or the weapons configuration of an attack helicopter. A specific statement may be that a French engineer regiment type unit has a wartime establishment of 500 regular troops, 150 drivers, 100 vehicles, 20 minelayers, and 20,000 mines.

3.4.2.2 The conceptual structure is illustrated in Figure 5. The entity *Establishment* associates an OBJECT-TYPE with other OBJECT-TYPEs. The various components that make up that *Establishment* are represented in entity *Establishment-Detail*. The words Establishment and Establishment-Detail are capitalised here to denote notional (conceptual) entities for purposes of exposition. They represent clusters of entities in the actual model. Establishment-Detail lists the numbers of a specific OBJECT-TYPEs authorised by a specific OBJECT-TYPE Establishment. Actual data structure is illustrated in Figure 6.

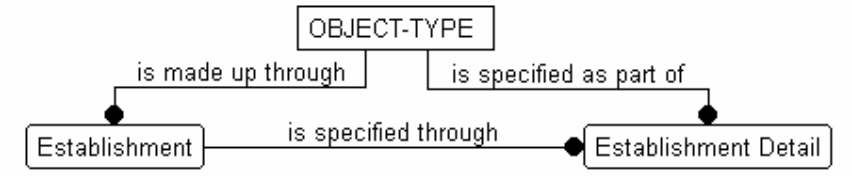

Figure 5. The Concept of Establishment

3.4.2.3 The entity ORGANISATION-TYPE-ESTABLISHMENT serves as a top-level descriptor to which are attached other entities that are designed to contain detailed data. These are specified in ORGANISATION-TYPE-ESTABLISHMENT-MATERIEL-TYPE-DETAIL, ORGANISATION-TYPE-ESTABLISHMENT-ORGANISATION-TYPE-DETAIL, and ORGANISATION-TYPE-ESTABLISHMENT-PERSON-TYPE-DETAIL. They are supported by Establishment Detail entities as follows:

a. Organisation-type detail pertains to one ORGANISATION-TYPE being composed of other ORGANIZATION-TYPEs.

b. Person-type detail specifies the data pertaining to types of persons belonging to an establishment (e.g. Sgt Infantry).

c. Materiel-type detail handles the data pertaining to types of materiel belonging to an establishment (e.g. Tank Leopard 2).

3.4.2.4 MATERIEL-TYPE-ESTABLISHMENT serves as the top-level descriptor to which is attached a single entity MATERIEL-TYPE-ESTABLISHMENT-MATERIEL-TYPE-DETAIL that stores the actual list of constituent MATERIEL-TYPEs. MATERIEL-TYPE-ESTABLISHMENT structure can be used to specify a bill of materiel or parts list. A parts list may catalogue components of a rifle, all items of equipment expected to be present on a combat-ready main battle tank, or enumerate all weaponry and equipment that is certified as a package for safe carriage on a given model of an F-16 fighter.

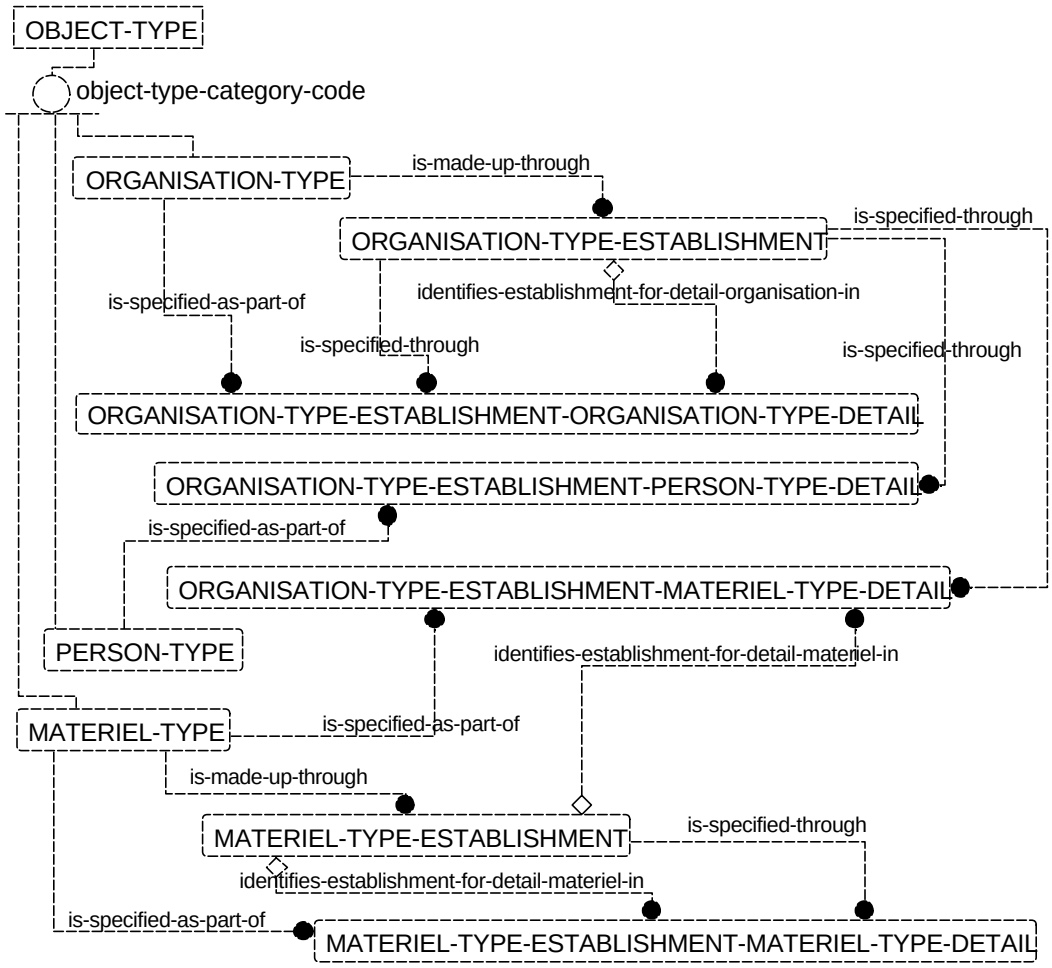

Figure 6. Specifying Establishments for Organisation and Materiel Types

3.4.2.5 There are three non-identifying (dashed-line) relationships in the figure. Their purpose is to permit unambiguous re-use of data in building establishment hierarchies. For example, if a company type has two establishments specified for it (say, summer peacekeeping and winter wartime) and it is being cited as a component of a task force type, the relationships enable the selection of one of the two establishments.

3.4.3 Assigning Establishments to OBJECT-ITEMs

There is a need to assign establishments to instances of OBJECT-ITEM. This is catered for by the use of MATERIEL-MATERIEL-TYPE-ESTABLISHMENT and ORGANISATION-ORGANISATION-TYPE-ESTABLISHMENT, as illustrated in Figure 7. This permits statements of the following kind: As of 1 March 1997, the 19th (US) Mechanized Division is assigned a specific Type Mechanised Division Establishment for war operations in a temperate climate. The establishment structure would provide the data about the types and numbers of subordinate organisations, equipment, and personnel for that division.

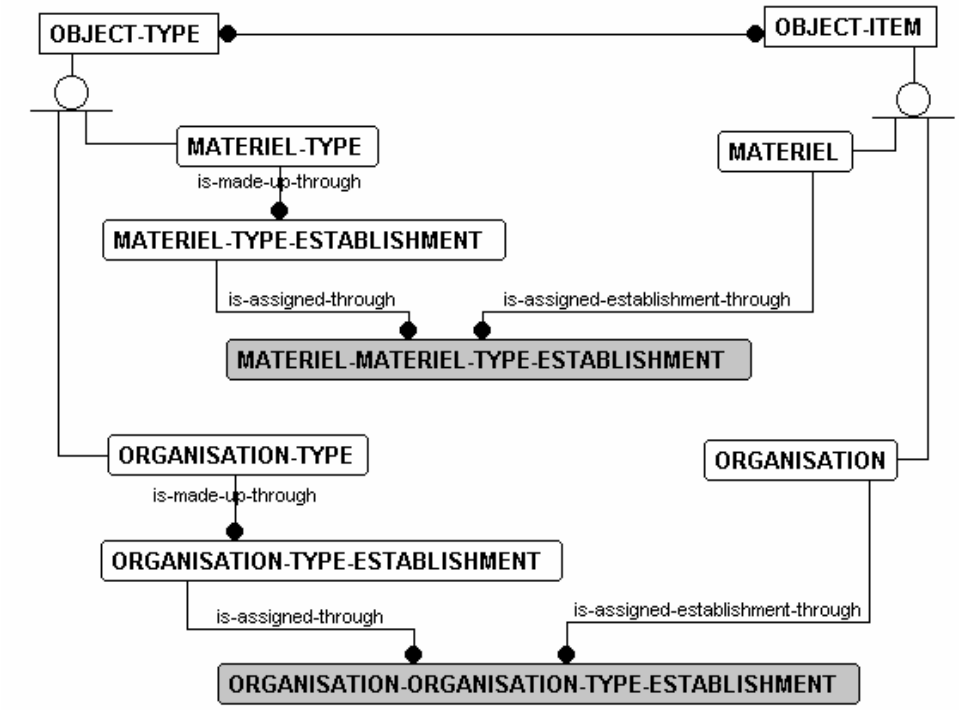

Figure 7. Assigning Establishments to ORGANISATION and MATERIEL

3.5 OBJECT-ITEM Structures

This section presents several topics that is part of the OBJECT-ITEM structure. These include the details of OBJECT-ITEM subtyping hierarchy, recording the status of instances of OBJECT-ITEM, specifying ways of accessing instances of OBJECT-ITEM via addresses and other forms, creating relationships between pairs of instances of OBJECT-ITEM, such as unit task organisation. The latter are called associations.

3.5.1 OBJECT-ITEM Subtype Hierarchy

3.5.1.1 Full OBJECT-ITEM subtype hierarchy is illustrated in Figure 8. The reader should note that the structure below the first subtype level is not parallel to the type side. The design is deliberate in response to requirements. Subtypes are created only when there are information elements that belong to a single object category. For example, there is no subtype under OBJECT-TYPE that is equivalent to METEOROLOGIC-FEATURE; yet this entity has seven subtypes of its own.

3.5.1.2 Some characteristics of OBJECT-ITEM or one of its subtypes may require that multiple values be maintained in a database at the same time. The technique for handling such cases in the model is to create child entities. Child entity depends on its single parent in a one-to-many relationship. The subtype hierarchy shows five instances of child entity: This section describes five such structures: MASS-GRAVE-CONTENT, NETWORK-FREQUENCY, NETWORK-SERVICE, PERSON-IDENTIFICATION-DOCUMENT, and PERSON-LANGUAGE-SKILL. The reasons for multiple values are clear from the following definitions and examples:

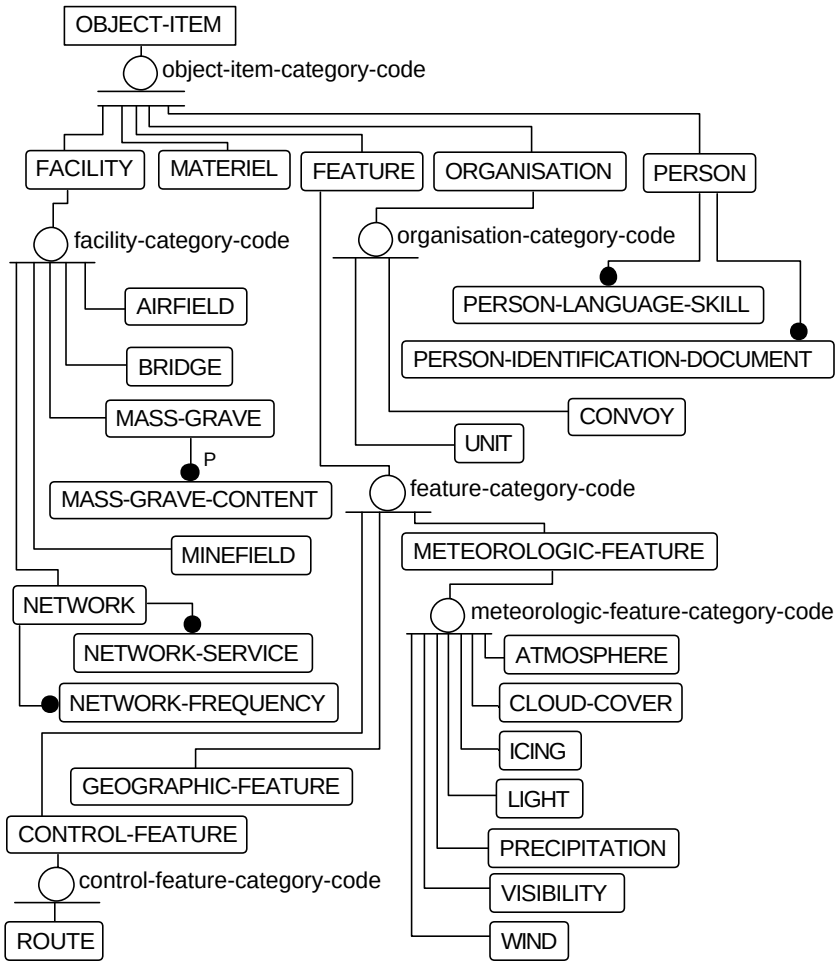

Figure 8. OBJECT-ITEM Subtype Tree

a. MASS-GRAVE-CONTENT—A content of bodies inside a specific MASS-GRAVE. The requirement is to specify the number of bodies according to age and gender.

b. NETWORK-FREQUENCY—The specification of a discrete frequency that is used on a specific NETWORK. A network uses multiple frequencies. It may be as simple as lower and upper bounds for a band or a set of frequencies for frequency hopping radios.

c. NETWORK-SERVICE—An identification of the specific type of communications service provided by a specific NETWORK. A network may simultaneously provide several services, the Internet being a good example.

d. PERSON-IDENTIFICATION-DOCUMENT— A document used to identify a specific PERSON. Almost every person carries multiple identification documents, such as driver licenses, military identification cards, and passports.

e. PERSON-LANGUAGE-SKILL—A proficiency or ability of a specific PERSON with regard to a specific language. A person may have skills in several languages or differing reading, writing and speaking skills in the same language.

3.5.1.3 There are two other entities that are child entities to OBJECT-ITEM itself and are not shown in a subtype hierarchy. These are OBJECT-ITEM-STATUS and OBJECT-ITEM-ACCESS, as presented in the next two sections.

3.5.2 Specifying Status of OBJECT-ITEMs

3.5.2.1 OBJECT-ITEM-STATUS is a record of the perceived condition of a specific OBJECT-ITEM. One of the attributes of OBJECT-ITEM-STATUS records a particularly significant item of information: the perceived hostility classification of a specific OBJECT-ITEM. The entity-level data structure is illustrated in Figure 9.

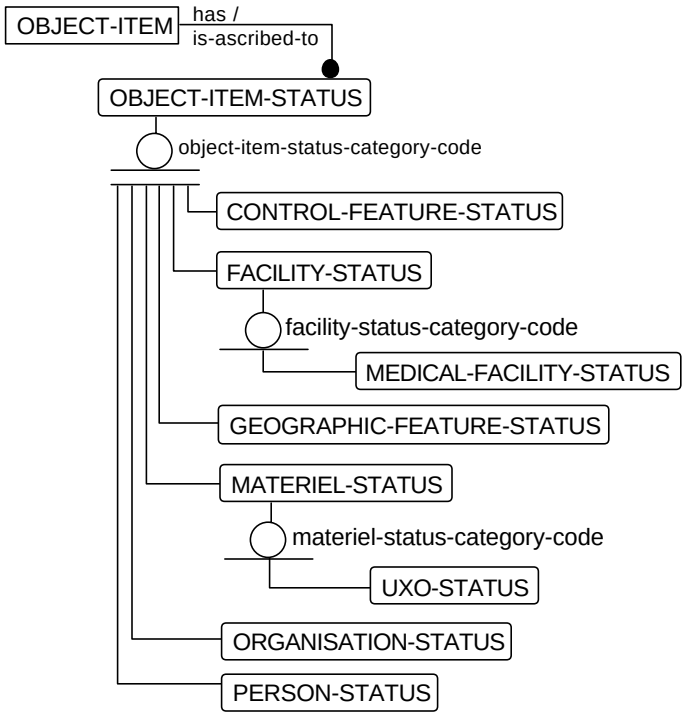

Figure 9. The Specification of Status for an OBJECT-ITEM

3.5.2.2 Subtypes of OBJECT-ITEM-STATUS hold the attributes that are tailored to describing the status of subtypes of OBJECT-ITEM. For example, the status of an enemy military ORGANISATION (a unit) could range from *fully operational* to *destroyed*; and the status of a soldier could be *ready*, *incapacitated*, *wounded*, *absent*, *missing*, *arrested*, *captured*, or *killed.* A control feature could be *activated* or *deactivated.*

3.5.2.3 Additional structure that is in the model under MEDICAL-FACILITY-STATUS but is not shown in the figure provides a number of details in terms of patient types, patient arrivals, medical condition types, surgical triage, surgical backlog, disposition of patients and so on.

3.5.2.4 Data structure permits multiple records to be kept about the status of an instance of OBJECT-ITEM to reflect changes that occur over time or differing status assessments that may be provided about a single OBJECT-ITEM by several units or

organisations, particularly when the subject of the assessment is an element of the opposing force.

3.5.3 Specifying Access to OBJECT-ITEMs

3.5.3.1 The OBJECT-ITEM-ACCESS structure provides addressing information for reaching an instance of OBJECT-ITEM by a number of different means. The structure is illustrated in Figure 10.

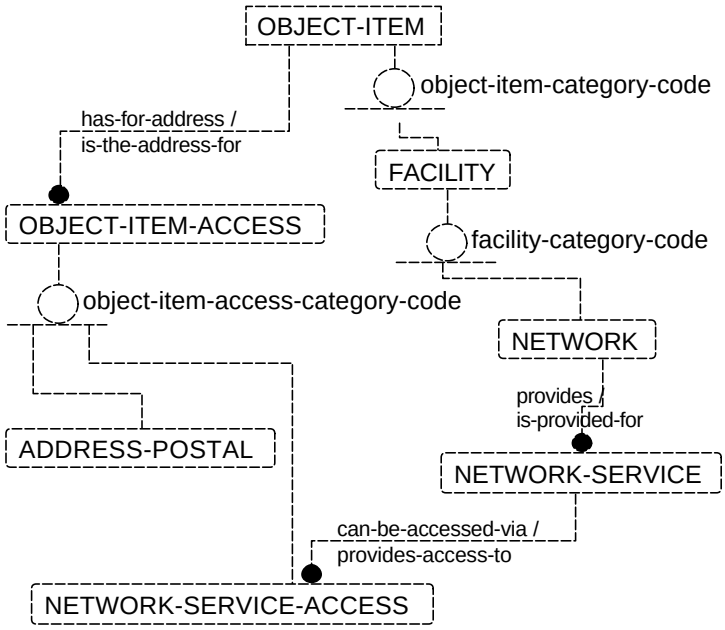

Figure 10. Providing Access to an OBJECT-ITEM

3.5.3.2 A mailing address can be entered through POSTAL-ADDRESS. Subtype NETWORK-SERVICE-ACCESS is connected to NETWORK-SERVICE that specifies the type of service that the network is providing. Some of the choices include electronic mail, facsimile, file transfer protocol, message service, telex, video, and voice. The actual address by which an organisation, a person or a facility can be reached is entered as data in NETWORK-SERVICE. There is also a provision to enter a call sign that would be used on a broadcast network. Any instance of OBJECT-ITEM may be assigned multiple contact addresses.

3.5.4 Associations between OBJECT-ITEMs

3.5.4.1 Every instance of OBJECT-ITEM has some type of relationship to another instance of OBJECT-ITEM in the sense of belonging, using, controlling, being constrained by, occupying and so on. For example, a division has full command of three brigades, or full command of two and operational control of the third if the third belongs to another nation. A specific main battle tank (MBT) is issued to a certain armoured infantry company. The model uses a simple structure to capture such information, as illustrated in Figure 11. All the relationships in the model are between subtypes of OBJECT-ITEM and relate either two different subtypes or a subtype with itself, such as an organisation to control feature and

one organisation to another. The associative entities are tied to their parents by relationships that specify one as the subject of the relationship and the other as the object. The category codes that are at the heart of the specification are aligned to read from subject to object. The status entity that is attached to each association records the starting and ending times of each association. An association can be made and broken multiple times.

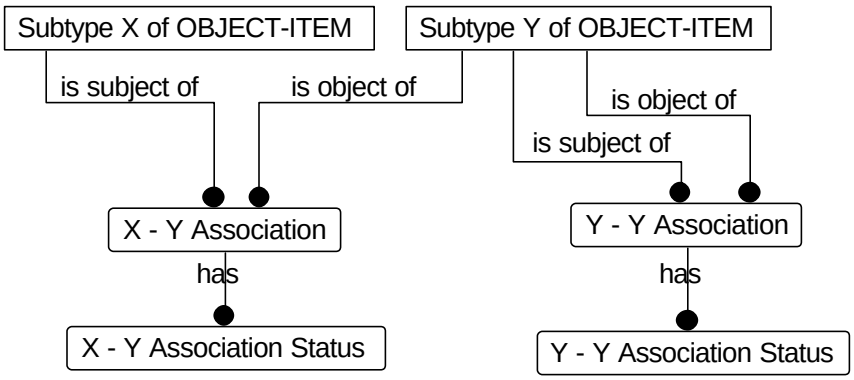

Figure 11. Concept for Object Associations

3.5.4.2 Those OBJECT-ITEM associations that are deemed necessary to support C2 are supported in LC2IEDM in the form of eleven pairs of associations shown in Table 10.

3.5.4.3 The meaning of associations for eleven OBJECT-ITEM relationships are specified by a category code, for which *example* values are shown to indicate the nature of the association along with an example of usage.

a. FACILITY-FACILITY-ASSOCIATION: Connected to; Contains; Utilises. Eglin Air Force Base contains Climatic Test Hangar.

b. FACILITY-FEATURE-ASSOCIATION: Encloses; Is affected by; Is bounded by; Is contained within; Is partially bounded by; Is partially contained within; Serves as. The Camp Blandford is bounded by a security perimeter.

c. CONTROL-FEATURE-CONTROL-FEATURE-ASSOCIATION: Contains; Is end of; Is part of; Is start of; Is successor of. Madrid-Toledo Route is successor of Segovia-Madrid Route.

Table 10. Valid OBJECT-ITEM Associations

	Object OBJECT-ITEM						
Subject OBJECT-ITEM	FACILITY	FEATURE	CONTROL-FEATURE	GEOGRAPHIC.-FEATURE	MATERIEL	ORGANISATION	PERSON
FACILITY	Yes	Yes	—	—	—	—	—
CONTROL-FEATURE	—	—	Yes	Yes	—	—	—
ORGANISATION	Yes	—	Yes	—	Yes	Yes	Yes
PERSON	—	—	—	—	Yes	—	Yes

d. CONTROL-FEATURE-GEOGRAPHIC-FEATURE-ASSOCIATION: Coincides with; Coincides with part of; Is partially delineated by; Is realised as. III Corps Fire Support Coordination Line (FSCL) is partially delineated by Heartbreak Ridge.

e. ORGANISATION-FACILITY-ASSOCIATION: Controls; Disestablishes; Establishes; Occupies; Uses. 5th Medical Brigade establishes Kosovo Field Hospital.

f. ORGANISATION-CONTROL-FEATURE-ASSOCIATION: Controls; Establishes; Is bounded by; Is constrained or enabled by; Is user of. 3rd Brigade is constrained by Alpha Restricted Fire Area.

g. ORGANISATION-MATERIEL-ASSOCIATION: Controls; Employs; Is accounting authority for; Is captor of; Transports. 733rd Maintenance Group is the accounting authority for Jet Engine SN 7XZ20388.

h. ORGANISATION-ORGANISATION-ASSOCIATION: Command and control, Fire unit and combat support, Administrative and combat service support, Supplementary. The category code for this entity is supplemented by a subcategory code that expands the choices available for each value of the category code. Example domain values are: Has as alternate; Has as reserve; Has attached; Has full command of; Has operational command of; Has operational control of; Has tactical command of; Has tactical control of; Has under command for administration. Task Force Blue Goose has tactical control of 6th Attack Helicopter Squadron until 1800 hours on 15 February.

i. ORGANISATION-PERSON-ASSOCIATION: Has as a liaison officer; Has on assignment; Has on attachment; Is captor of; Is under command of. The 2nd Green Berets Brigade is under command of Colonel John Wayne.

j. PERSON-MATERIEL-ASSOCIATION: Controls; Employs; Is accounting authority for; Is captor of; Is owner of; Transports. Private Smythe transports the Kohinoor diamond.

k. PERSON-PERSON-ASSOCIATION is somewhat different from the others in that the category code indicates only next of kin, such as Father, Mother, Brother, Sister and so on.

3.6 Capabilities of Items and Types

3.6.1 Specifying and monitoring capability of battlespace objects can be an important factor within the military planning process. Knowledge about capability may help in analysis of feasible actions that are open to friendly forces or in assessing the likelihood

of actions that may be open to enemy forces. Capability statements can also be subject to various kinds of conditions. For example, the speed with which a vehicle can manoeuvre over land may depend on the type of terrain, and the range of a weapon may depend on the type of ammunition that is used. Capability structure is designed to embody two concepts: the need to characterise capability itself and to link it to other parts of the model that use specifications of capability. The structure is illustrated in Figure 12.

3.6.2 CAPABILITY is defined as the potential ability to do work, perform a function or mission, achieve an objective, or provide a service. The entity represents the list of generic capabilities that are available to objects and their types. This list covers a diverse range of abilities such as their maximum speed or their maximum storage capacity, some of which may not be applicable to certain classes of objects. The list of abilities is stored in the attributes capability-category-code and capability-subcategory-code. The category-code refers to a general class of abilities (e.g., the ability to transport things) while the subcategory-code refers to a single ability within that class (e.g., the ability to transport a given amount of liquid).

3.6.2 Subtypes of CAPABILITY add amplifying information for certain classes of capability. Some are linked to subtypes of OBJECT-TYPE in order to permit more precise specification. For example, FIRING-CAPABILITY is linked to AMMUNITION-TYPE and STORAGE-CAPABILITY is linked to MATERIEL-TYPE.

3.6.3 CAPABILITY is linked to three independent entities in order to provide the following functions:

a. Specify the expected or normal capability for OBJECT-TYPEs.

b. Estimate or record the actual capability of OBJECT-ITEMs.

c. State (through ACTION-REQUIRED-CAPABILITY) the *required capability* of OBJECT-ITEMs or OBJECT-TYPEs when they are needed as resources for carrying out ACTIONs.

3.6.4 Expected / Normal Capability. The entity OBJECT-TYPE-CAPABILITY-NORM is defined as the standard value of a specific CAPABILITY of an OBJECT-TYPE. Since the entity relates to types rather than items, the data it contains will tend to be static. The entity represents staff planning data concerning the capabilities of different OBJECT-TYPEs. The data can be used to:

a. Provide a broad threat analysis in terms of enemy or potentially hostile OBJECT-TYPEs.

b. Assist in the selection of friendly OBJECT-TYPEs for the tasks to be done.

c. Aid an application program in classifying OBJECT-TYPEs in accordance with operational user's preferences.

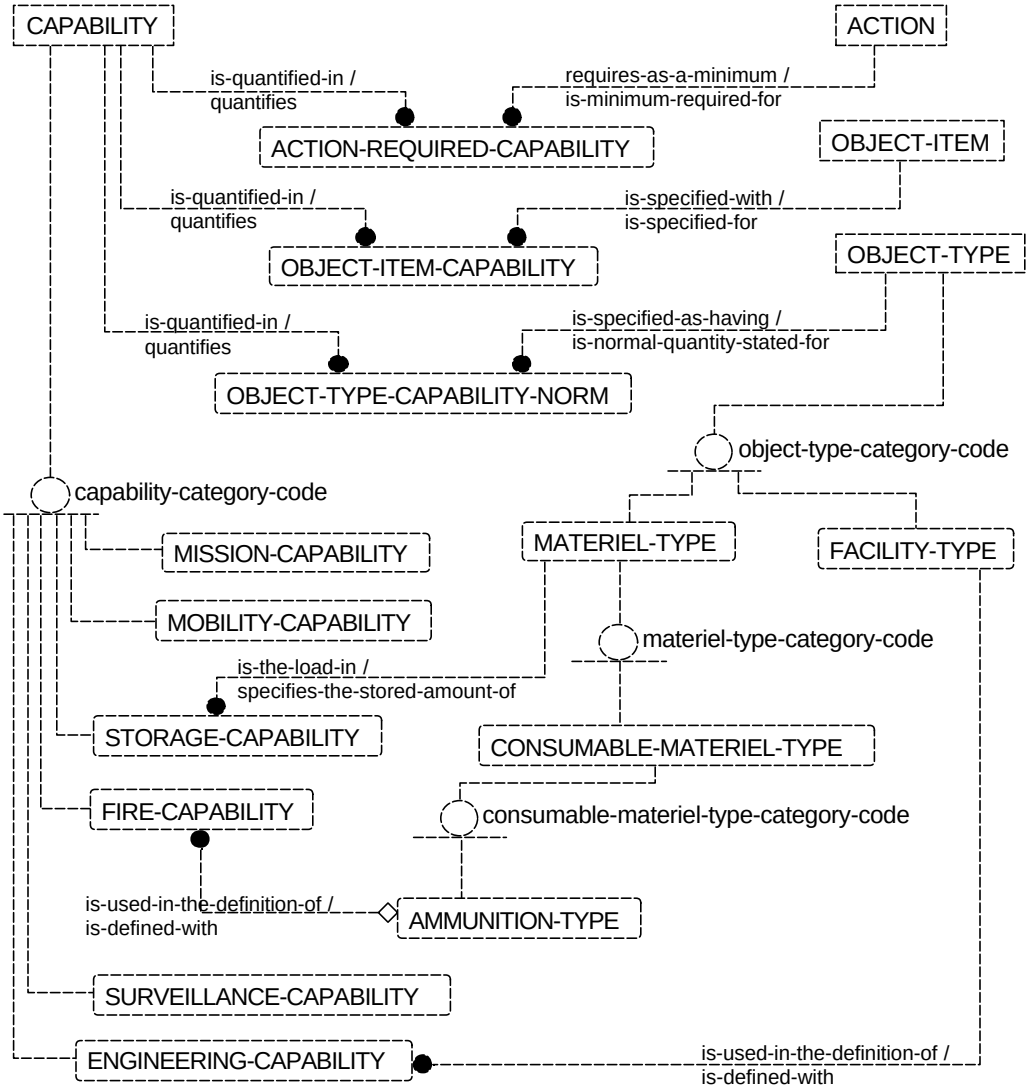

Figure 12. Specifying Capabilities of Objects

3.6.5 Actual Capability. The capabilities of individual OBJECT-ITEMs may differ from the norm due to attrition or other factors. OBJECT-ITEM-CAPABILITY holds the perceived value of a specific CAPABILITY of an OBJECT-ITEM where it differs from the norm or where there is no norm. As well as recording detail of friendly troops, OBJECT-ITEM-CAPABILITY could hold a threat analysis for individual enemy OBJECT-ITEMs, e.g., an enemy tank regiment may have demonstrated a capability to move at a faster rate than its OBJECT-TYPE-CAPABILITY-NORM.

3.6.6 Required Capability. It is necessary to be able to specify a required CAPABILITY in order to complete an ACTION. This enables optimal resource usage for planning as well as for managing resources during the life of an ACTION. This subject is elaborated when extensions to ACTION structure are presented.

3.7 Positioning and Geometry for OBJECT-ITEMs

3.7.1 Concept for Representing Location and Geometry

3.7.1.1 The data structure under the independent entity LOCATION captures two distinct but related concepts of interest to planners and operators in the battlespace:

(a) Specification of geometry that is required to describe battlespace objects;

(b) Placement of battlespace objects or their geometry with respect to the Earth's surface or with respect to each other.

3.7.1.2 The ability to specify geometry permits the description of various open or closed boundaries, such as areas of responsibility, orbits, phase lines, and objectives, as well as the shape of airfields, runways, ammunition dumps, and a security fence surrounding an ammunition dump. The positioning of battlespace objects with respect to the Earth's surface is achieved by associating the entities representing battlespace objects with the LOCATION entity.

3.7.2 Overview of Location Structure

3.7.2.1 Overall structure for specifying location and geometry is shown in Figure 13 at the entity level. For the most part, LOCATION structure is self-contained and independent of other parts of the model. One exception occurs when a coordinate system is set up relative to some battlefield object. This is shown by the relationship between OBJECT-ITEM-LOCATION and OBJECT-REFERENCE.

3.7.2.2 The basic element is a point; it plays a role in generating every other geometric construct in the specification. The location of the point can be expressed either in absolute terms with respect to a standard description of the earth's surface or in relative terms with respect to another point that may be absolute or relative itself. The vertical distance for a point may be specified in several ways: as a measured altitude with respect to mean sea level, a measured height with respect to ground or water level, a pressure altitude or pressure height, or simply stated to be the local surface, as would be the case for an armoured vehicle moving through the countryside.

3.7.2.3 Lines are generated from a series of points that are connected in a specified order. The part of a line between two successive points is a line segment; a sequence of connected line segments defines the line, or more properly a *polygonal path.* A line may close on itself if the first and last points that define the line are the same; in this case a line may serve as a boundary for a surface. If the first and last points are not the same, then the line is an open line, such as a phase line or a one-way route.

3.7.2.4 Surfaces are built either directly from lines or the points provide part of the specification. For example, a polygon area is defined by a closed boundary line. An ellipse is completely defined by three points. Almost any figure, even an ellipse, could be approximated by a polygonal area; however, it is somewhat more efficient to provide explicit specifications for some of the figures that are called for in the operational requirements, and in some cases it is essential since not all geometric aspects can be completely described by polygons. For example, the specifications for corridor, orbit, and track require additional parameters as will be described in subsequent sections.

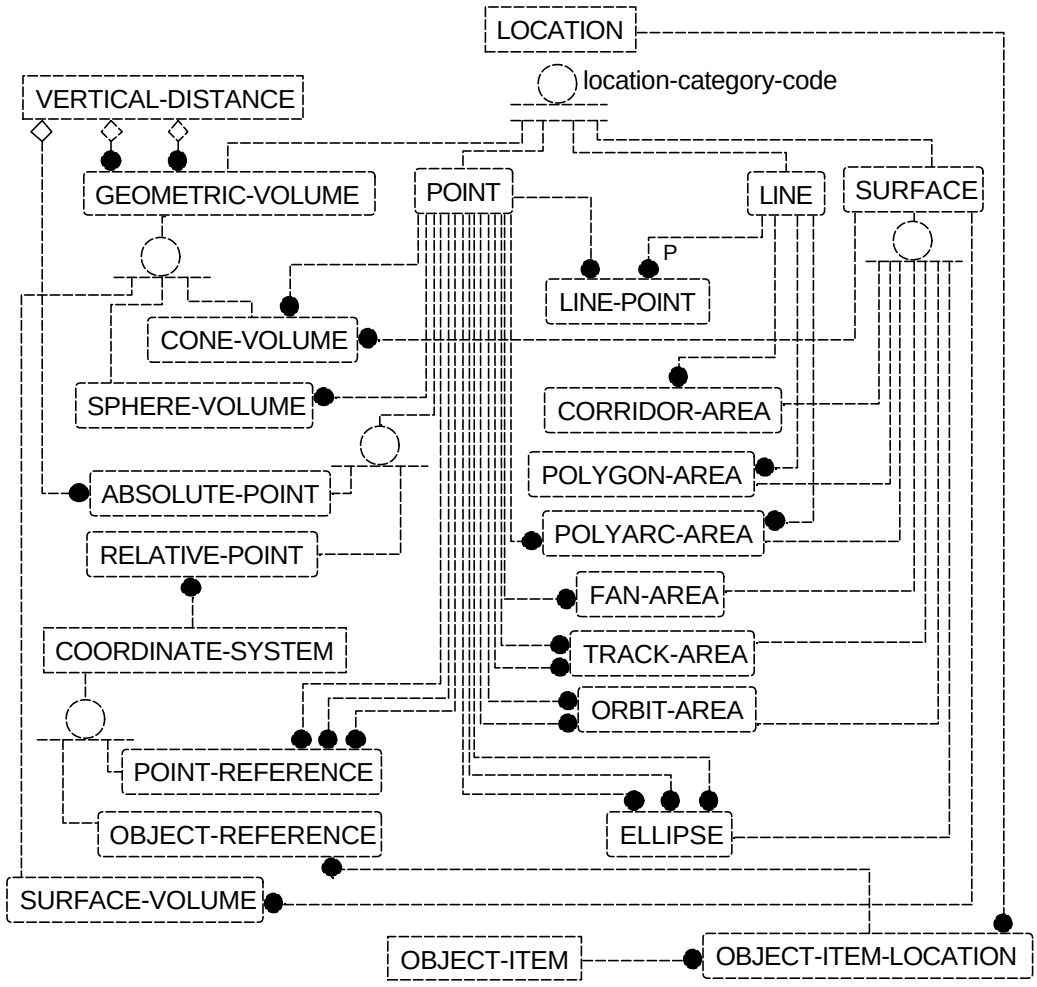

Figure 13. Entity-Level View of the LOCATION Structure[9]

3.7.2.5 Most volumes are built by using the horizontal projection of a surface onto the Earth's surface to define the outer boundaries of a general cylinder and to specify the top and bottom vertical distances to close off the volume. Thus, any of the geometric figures that are constructed as surfaces can be the basis for a volume. Two additional volume geometries—cones and spheres—do not follow this pattern and require individual specifications.

3.7.3 Supporting Structures

LOCATION structure is supported by additional specifications for vertical distance and a coordinate system to enable relative geometry. The independent entity VERTICAL-DISTANCE is a specification of the altitude or height of a point or a level as measured with respect to a specified reference datum in the direction normal to the plane that is tangent to the WGS84 ellipsoid of revolution. Specification of COORDINATE-SYSTEM enhances

[9] The relationship between COORDINATE-SYSTEM and RELATIVE-POINT is non-identifying (dotted line) but appears to be identifying (solid line) in the figure.

functionality of LOCATION by establishing a local reference frame. COORDINATE-SYSTEM has two subtypes: one defines a coordinate system with respect to an arbitrary point and the second with respect to location of an object. If the object is moving or changing its orientation, then the coordinate system is also changing. Any geometry that is specified relative to this coordinate system will also move with it.

3.7.4 Linking LOCATIONs and OBJECT-ITEMs

Model construct relates OBJECT-ITEM to LOCATION through the associative entity OBJECT-ITEM-LOCATION. The overall view for associating battlespace objects with LOCATION is presented in Figure 14. OBJECT-ITEM-LOCATION has an optional non-identifying relationship to CONTROL-FEATURE-TYPE in order to give operational meaning, as needed, to any geometry specified in LOCATION.

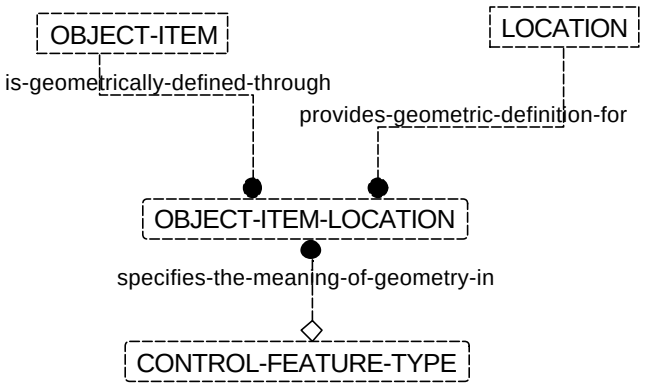

Figure 14. Specifying Position and Geometry for OBJECT-ITEMs

3.8 Relationships between Items and Types

This section deals with three sets of direct relationships between items and types: classification of items according to type, possession of types by items, and the identification of organisational responsibility for selected reporting codes associated with types of materiel. The first two are critically important.

3.8.1 Classification of OBJECT-ITEMs by Type

3.8.1.1 A specific OBJECT-ITEM must be associated with at least one instance of OBJECT-TYPE. This is a fundamental structural feature of the model. Data elements are defined on the type or item side as is most appropriate and the information needs to be shared between the two sides. The ability to classify OBJECT-ITEMs as OBJECT-TYPE makes any information that is stored as type data applicable to the item. Thus, any characteristic of an item that can be described as a type property does not need to be carried as an attribute on the item side.

3.8.1.2 The linkage between item and type permits the recording of differing interpretations of what the type of an item may be, especially in regard to opposing forces or any other assessment that is based on uncertain or incomplete information. For example, Unit A may classify an unknown object first as a vehicle, then successively (as better

information becomes available) an armoured vehicle, a tank, a main battle tank, and a T72. It also permits the recording of differing interpretations of the same object by different organisations. Unit B may be looking at the same object as Unit A but classify it successively as a vehicle and an APC. The structure also enables a history of classifications to be kept as a means for understanding the decisions that were made at the time a classification was considered valid. In other words, the data may be able to provide exonerating evidence in case of a court martial.

3.8.1.3 The many-to-many relationship between OBJECT-TYPE and OBJECT-ITEM that was shown in an earlier figure is resolved by an associative entity called OBJECT-ITEM-TYPE. It is defined as a record of the perceived classification of a specific OBJECT-ITEM as a specific OBJECT-TYPE. The structure is illustrated in Figure 15. The relationship is read as follows: an OBJECT-ITEM is classified as one or more OBJECT-ITEM-TYPEs. The letter P at the "many" end stands for "positive." P designation makes the classification of an instance of OBJECT-ITEM mandatory rather than optional.

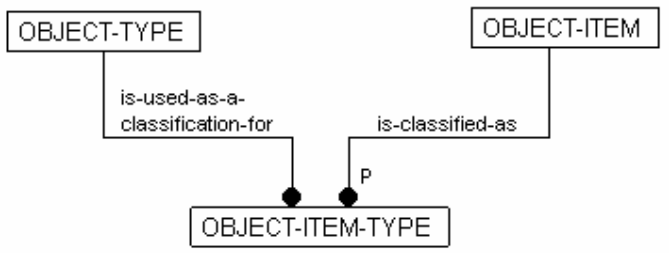

Figure 15. Classifying OBJECT-ITEMs According to Type

3.8.2 Holdings by Items

3.8.2.1 The concept of holding addresses the association of a specific object (OBJECT-ITEM) with a class of objects (OBJECT-TYPEs) where the relationship is defined by the general notion of inclusion in the sense of ownership, possession, assignment, or control. The staff officer may wish to know how many tanks of a given type a certain unit possesses and how many of them are operational, or how many enemy companies there are within a given area, or how many rounds of an ammunition type are stored in a particular arsenal, or how many cargo pallets are contained on a particular airlift aircraft, or how many mechanics does a given maintenance company have, or which types of weapons and sensors are held by a specific weapons platform (e.g., the load of weapons carried by a specific close air support aircraft). This type of information can be recorded in the data structure that is described in this section.

3.8.2.2 Holding specifies what an OBJECT-ITEM actually has or is estimated to have at a particular time. The holding may be an estimate for a future date, such as the expected count of a given type of equipment a week from now. In this way, expected replenishment or repair of materiel can be reflected in the holdings that serve as one of the sources of information for combat operations planning.

3.8.2.3 The key requirement in specifying holdings for the purpose of international exchange of information is assumed to be the total quantity and the part of the total that is considered to be in an operational status. Consequently, a simple structure is used in the model, as shown in Figure 16.

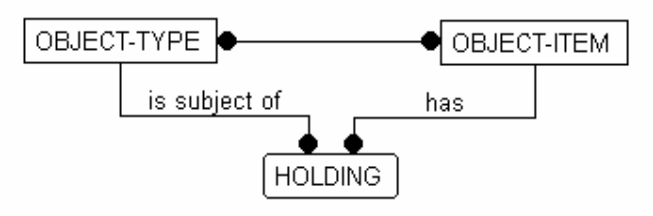

Figure 16. The HOLDING Entity

3.8.2.4 The figure illustrates two fundamental relationships:

a. An OBJECT-ITEM is the holder cited for a HOLDING.

b. An OBJECT-TYPE is included in a HOLDING.

3.8.2.5 The HOLDING structure illustrated in the figure permits the participation of any of the OBJECT-ITEM subtypes with any of the OBJECT-TYPE subtypes. If any restriction were to be placed on allowable combinations of items and types for HOLDING, it would have to be done with business rules.

3.8.2.6 A subsequent chapter introduces the concept of establishment as a way of relating an OBJECT-TYPE to another OBJECT-TYPE. Such an establishment details what an OBJECT-TYPE is authorised to have in terms of other OBJECT-TYPEs. An establishment assigned to a particular OBJECT-ITEM shows what the OBJECT-ITEM is authorised to have. Comparison of establishment and holding can disclose information about surpluses and deficiencies.

3.8.2.7 Previously discussed ***Establishment*** indicates what an organization or materiel is supposed to be composed of; **HOLDING** captures what the organization or materiel actually contains. In other words, the difference between HOLDING and Establishment is that whereas Establishment details what an OBJECT-TYPE is authorised to have in terms of other OBJECT-TYPEs, HOLDING details what an OBJECT-ITEM actually has (or is thought to have) at a particular time. This concept enables the establishment of logistic/personnel replenishment requirements as well as an assessment of organizational capability.

3.8.3 Identifying Reportable Items

3.8.3.1 An organisation, such as NATO HQ or a regional headquarters, may create lists of materiel types using a standard coding scheme for reporting purposes. One such specification is a Land Forces Reportable Item List (LFRIL). An organisation may choose to create a LFRIL in order to enforce standard reporting about equipment (type of materiel) that its subordinate organisations hold.

3.8.3.2 The model includes an associative entity ORGANISATION-MATERIEL-TYPE-ASSOCIATION in order to enable the designation of instances of MATERIEL-

TYPE with a LFRIL code. The linkage to organisation is necessary since the codes and the membership of the list can vary according to the organisation that creates the list. The structure is illustrated in Figure 17.

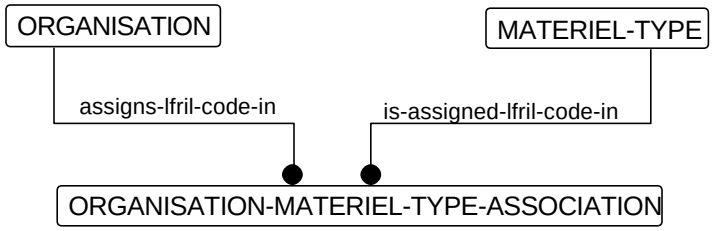

Figure 17. Assignment of LFRIL Designation to MATERIEL-TYPE

3.9 ACTION: Planning and Conducting Battlespace Operations

3.9.1 Introduction

3.9.1.1 The discussion now turns to the second major structural part of the model. This chapter describes the basic concepts for representing *activity* in the model. The independent entity ACTION is the root for this representation. The related structure includes mechanisms for specifying battlespace objects or classes as resources and objectives for activity, recording effects of activity, classifying activities as planned tasks or unplanned events, keeping status of activities, and relating activities to each other functionally and temporally.

3.9.1.2 ACTION together with its substructures specifies and describes operations planned for or carried out in the battlespace. It is also used to describe unplanned happenings that are of military interest. The underlying concept for modelling ACTIONs is based on a statement in which something carries out an activity to affect something at some time. Within the model, the "something" within the basic action statement is described by an OBJECT-TYPE or an OBJECT-ITEM. Thus, OBJECT-TYPEs and OBJECT-ITEMs are related to ACTION in two distinct ways: as resources and as objectives. There is yet a third relationship between ACTION and battlespace objects that characterises the effects of ACTIONs. The three principal relationships to battlespace objects are illustrated in Figure 18. The figure also shows two associations that link sets of ACTIONs functionally and temporally. Complex statements, such as operations orders, can be constructed by relating simple statements in cascading hierarchies.

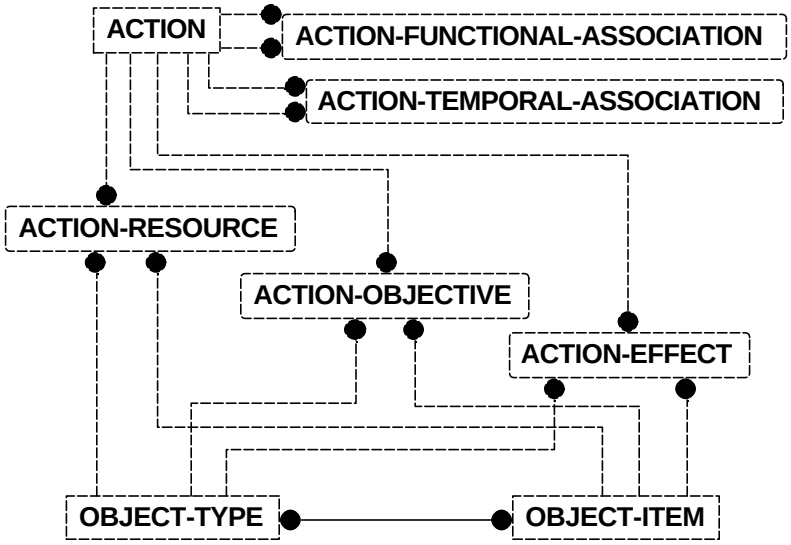

Figure 18. The Primary Model Structure for ACTION

3.9.2 Role of Objects as Resources, Objectives, and Subjects of Effects

3.9.2.1 Entities ACTION-RESOURCE and ACTION-OBJECTIVE have been introduced in order to be able to assign roles to OBJECT-ITEMs and OBJECT-TYPEs as part of an ACTION specification.

3.9.2.2 ACTION-RESOURCE is defined as an OBJECT-ITEM or an OBJECT-TYPE that is required, requested, allocated or otherwise used or planned to be used in conducting a specific ACTION. ACTION-RESOURCEs are those OBJECT-ITEMs and OBJECT-TYPEs that have been specified as the things performing, things being used in or allocated to, or things whose use is qualified in some way, in carrying out a specific ACTION.

3.9.2.3 ACTION-OBJECTIVE is defined as the focus, in terms of an OBJECT-ITEM or OBJECT-TYPE, in conducting a specific ACTION. ACTION-OBJECTIVEs are those OBJECT-TYPEs or OBJECT-ITEMs that are specified to be (or excluded from) the focus of an ACTION.

3.9.2.4 As an example of resources and objectives, the 11th (NL) Air Mobile Brigade may use 4 Chinook helicopters (an ACTION-RESOURCE) to transport 100 troops to a landing zone (ACTION-OBJECTIVEs).

3.9.2.5 Effectiveness of operations needs to be monitored and the potential effects of planned or pending activity need to be estimated. To this end, ACTION-EFFECT is defined as a perceived effectiveness of a specific ACTION against a specific battlespace item or its type. For example, the reported result may be that the enemy force has been diminished by at least 50 percent and the enemy position was captured.

3.9.2.6 The ACTION-EFFECT estimate specifies a quantity if the objective is an OBJECT-TYPE, or a fraction if the objective is an OBJECT-ITEM. Operations performance could be evaluated by comparing ACTION-EFFECTs to stated ACTION-OBJECTIVEs. It should be noted that ACTION-EFFECT permits the capture of information

about effects of ACTIONs on objects that are not necessarily the objectives of the ACTION. This can be referred to as *collateral damage*, for example, the intended target was an ammunition plant but a nearby hospitalwas hit.

3.9.3 Relating ACTIONs

3.9.3.1 General. The promulgation and understanding of an operations order is dependent upon the complex linkage of a series of assigned actions (tasks). These tasks are ***linked functionally*** (e.g. The Corps Barrier Zone Completion is decomposed into several Divisional Barrier Zone tasks which is then further decomposed into Brigade Barrier Zone tasks and so on). There is also a ***temporal*** dimension that indicates that Action A cannot start before Action B is completed (e.g., A unit cannot achieve Phase Line 2 until it has achieved Phase Line 1. The Generic Hub provides two associative entities that specify the dependencies between ACTIONs and allow for the creation of hierarchies:

a. ACTION-FUNCTIONAL-ASSOCIATION caters to functional relationships; and

b. ACTION-TEMPORAL-ASSOCIATION caters to time-specific dependencies between ACTIONs.

3.9.3.2 ACTION-FUNCTIONAL-ASSOCIATION. The entity ACTION-FUNCTIONAL-ASSOCIATION records the relationship of a specific ACTION as being dependent on, supporting, or derived from another specific ACTION. The categories of association include the following phrases:

> Has as a provisional sub-ACTION, Has as a sub-ACTION, In order that, In response to, Is a modification of, Is a prerequisite for, Is a template for, Is an alternative to, Uses as a reference.

The simplest relationship is where an ACTION includes a number of other subordinate ACTIONs. This is represented in Figure 19, where Action 2 is the major action that is supported by Action 1. Action 1 consists of four ACTIONs (Action 3 to Action 6); three of the actions are subordinated to Action 1 directly (Action 3 to Action 5), while the fourth action (Action 6) is subordinated to Action 5. In this example, the relationship hierarchy can be represented by the phrases as "Is a sub-Action of" in case of connecting lines and "In order that" for the support.

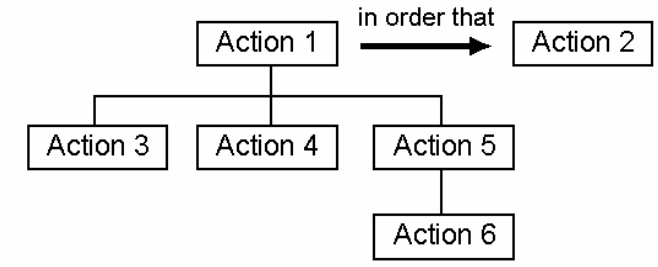

Figure 19. ACTION Hierarchy

3.9.3.3 ACTION-TEMPORAL-ASSOCIATION. The timings of sub-actions that are part of a complex action will frequently be interdependent. The entity ACTION-TEMPORAL-ASSOCIATION is designed to handle the data requirements associated with

temporal dependencies between ACTIONs. ACTION-TEMPORAL-ASSOCIATION is the assignment of an ACTION (i.e., ACTION-TASK) to be time-dependent for its execution on another ACTION (e.g., ACTION-EVENT or ACTION-TASK).

3.9.3.4 Absolute Temporal Dependence. There are several ways to establish temporal dependence. The simplest method and one that does not require the entity ACTION-TEMPORAL-ASSOCIATION is through the use of absolute time when such specification is appropriate. In this method, the absolute start and end times are specified using the attributes in ACTION-TASK (to be described) so that the sub-tasks are carried out in the correct sequence.

3.9.3.5 Relative Temporal Dependence. In many cases, the required start time of the overall action is not known, or perhaps the unit tasking the ACTION is flexible with regard to the exact time the sub-actions are to start or end provided they start or end at some time relative to another action. In order to specify temporal dependence the concept of temporal relationships has been employed. These are characterised by phrases such as "Starts at the end of," "Starts during and ends after," and "Starts at the same time and ends after." These temporal relationships permit specification of the relative order in which ACTIONs are to occur without stating any actual times.

3.9.3.6 Offset Temporal Dependence. The temporal association also provides the flexibility of specifying fixed offset intervals, wherein a subject ACTION is to start at some specified time interval before or after a particular reference point in the object task. For example, the transportation of troops may be part of a larger mission to attack a position held by the enemy, requiring that the movement to the landing zone be executed 30 minutes before the attack starts.

3.9.3.7 ACTIONs can be related together in very complex ways using the concepts of absolute time, temporal relationships, and temporal relationships with offset intervals. It is possible to formulate plans without specifying a particular start time (or H-hour) while still being able to specify the interrelated time dependencies between its constituent sub-actions. In order to fix a start time for such a plan, it is merely necessary to introduce a new ACTION, with a specified planned start time, and relate it to the ACTIONs to be initiated, e.g., H-hour will be 0900, 15 August 2002.

3.9.4 Subtypes of ACTION

3.9.4.1 ACTION structure is used to describe different kinds of activities that entail different data requirements. For that reason, ACTION is subtyped into ACTION-EVENT and ACTION-TASK. The structure is shown in Figure 20. Status entities allow progress of activities to be recorded. Two entities—NBC-EVENT and ACTION-EVENT-DETAIL—are associated with ACTION-EVENT to handle specialised data requirements.

3.9.4.2 ACTION-TASK is defined as an ACTION that is being or has been planned and for which the planning details are known. It concerns those ACTIONs over which control can be exercised or which are predicted (such as friendly operations, and those enemy activities that have been predicted as a result of intelligence assessment). It can represent actions that are typically found in plans, orders, and requests.

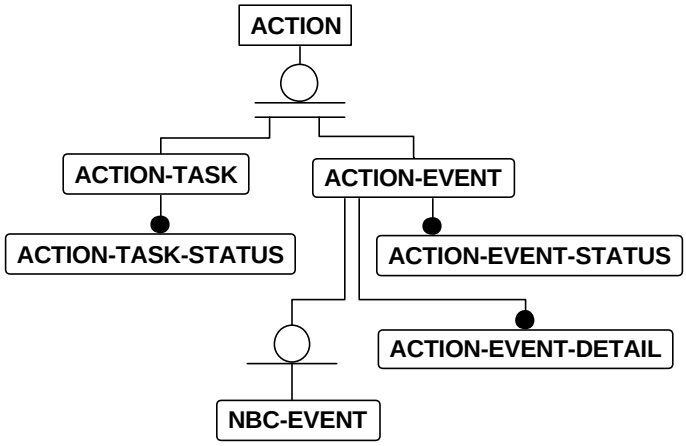

Figure 20. Subtypes of ACTION

3.9.4.3 ACTION-EVENT is defined as an ACTION that is an incident, phenomenon, or occasion of military significance that has occurred or is occurring but for which planning is not known. This entity is intended to capture ACTIONs that simply occur and need to be noted. An ACTION-EVENT may trigger a new ACTION-TASK. For example, the encounter of a scattered minefield near the landing zone will result in an evasive manoeuvre. An observer in the battlespace may also use ACTION-EVENT to report his sightings that result from a recorded ACTION-TASK of which he has no knowledge.

3.9.4.4 Status entities permit the monitoring of the effectiveness and progress of both tasks and events as follows:

a. ACTION-TASK-STATUS captures the perceived appraisal of the planning and execution progress of a particular ACTION-TASK in fractional terms or through the reporting of actual starting and ending dates and times.

b. ACTION-EVENT-STATUS reports the perceived appraisal of the actual progress of an ACTION-EVENT as determined by the reporting organisation. The progress is estimated fractionally at a given date and time; therefore, fraction 0 would coincide with a starting date and time and fraction 1 with the end.

3.9.4.5 Using Effectiveness and ACTION-TASKS. ACTION-TASK-STATUS specifies the progress of the ACTION-TASK towards completion without referring to the effectiveness of the ACTION-TASK vis a vis specified objectives. This can be used to monitor the progress of occurring ACTION-TASKs, as well as to provide an estimate of future progress of planned, expected, or ordered ACTION-TASKs.

3.10 Broadening Functionality of ACTION

3.10.1 Introduction

A number of model constructs add to the scope of data that can be captured to enrich a specification of ACTION:

a. Extending specification of ACTION-OBJECTIVE to TARGET

b. Extending specification of ACTION-TASK to REQUEST

c. Specifying required capabilities

d. Designating roles of an organisation with respect to ACTION

e. Specifying constraints or guidance on the use of ACTION-RESOURCE

f. Imposing rules of engagement

g. Providing CANDIDATE-TARGET-LIST as an aid in operational planning

h. Linking ACTION to CONTEXT as a mechanism for specifying or recording starting, intermediate, or ending conditions.

3.10.2 ACTION-OBJECTIVE as TARGET

3.10.2.1 Some instances of ACTION-OBJECTIVE may be targets that require additional data specifications. These consist of three entities—TARGET with its child entities TARGET-MARKING and TARGET-PERSONNEL-PROTECTION—as illustrated in Figure 21. The figure also shows the relationships to each other and their identifying and non-identifying relationships from ACTION-OBJECTIVE-ITEM, OBJECT-ITEM, and ORGANISATION. The three principal entities are described below.

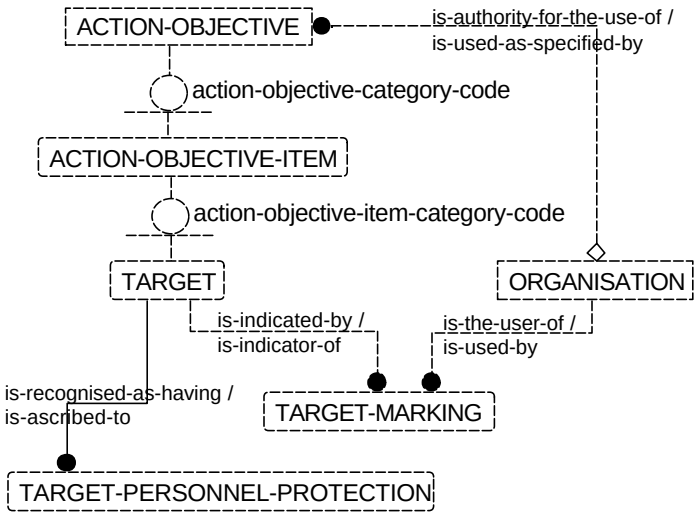

Figure 21. TARGET Structure

3.10.2.2 TARGET is a subtype of ACTION-OBJECTIVE-ITEM. Since ACTION-OBJECTIVE-ITEM is the focus of an ACTION against a specific OBJECT-ITEM, TARGET may be an entity used to specify the focus of air-defence, direct fire support, reconnaissance, and other operational tasks. TARGET is defined as an ACTION-OBJECTIVE-ITEM that is subject to capture or destruction by military forces or against which military intelligence operations are directed.

3.10.2.3 TARGET-MARKING is defined as the technique of indicating the position of a TARGET at a given time for the benefit of a using ORGANISATION. TARGET-MARKING is used to specify requirements, plans, and results of marking a TARGET position or an associated reference position. Assignment of the resource that

provides target marking services is specified in ACTION-TASK. TARGET-MARKING provides an opportunity to add co-ordinating details for the user of the marking services.

3.10.2.4 TARGET-PERSONNEL-PROTECTION is defined as an assessment of the general protective posture of personnel with respect to first and second volleys for the specific TARGET. The protective posture refers to states such as standing, prone, dug in, and under cover. It captures the change of state, if any, between the first volley and the second volley. For example, personnel may have been prone at the first volley, but may be dug in at the second volley.

3.10.3 REQUEST for Intelligence and Combat Information

3.10.3.1 Requests for intelligence need to be linked to the products of surveillance and reconnaissance. A REQUEST is a special instance of ACTION-TASK that can use all the functionality of the ACTION structure to specify a requirement to collect information. The execution planning in response to the request would be done within the same structure as any other ACTION. Once the collection is complete, one or more REQUEST-ANSWERs can be created. The structure for REQUEST-ANSWER is illustrated in Figure 22.

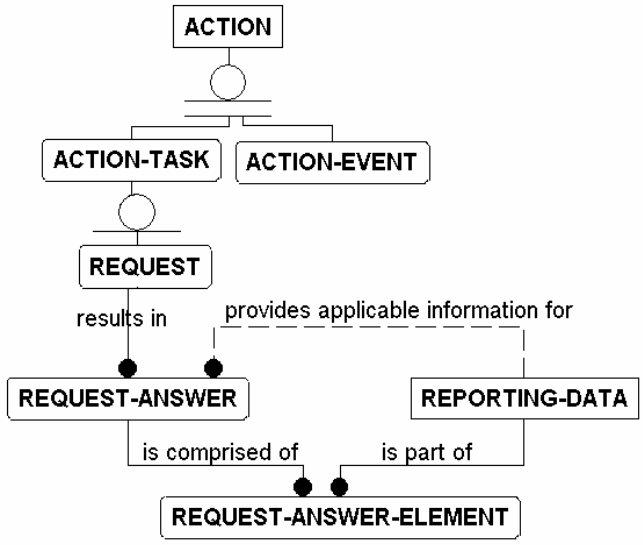

Figure 22. A Mechanism for Handling Intelligence and Combat Information

3.10.3.2 Affirmative REQUEST-ANSWER indicates that additional information may be recorded elsewhere in the model. The pointer to such information is implemented through the entity REQUEST-ANSWER-ELEMENT. For example, a hostile unit may have been located at a given coordinate as a result of a search for enemy units in a prescribed region. This information would be recorded in OBJECT-ITEM-LOCATION that is linked to REPORTING-DATA (subject to be described in a subsequent section). An instance of REQUEST-ANSWER-ELEMENT would then be able to indicate the correct instance of REPORTING-DATA that is part of the REQUEST-ANSWER.

3.10.3.3 Negative entry in REQUEST-ANSWER is actually a genuine piece of information that cannot be recorded elsewhere. If the search for hostile units results in none being found, then that finding is recorded in REQUEST-ANSWER.

3.10.4 Capabilities Required for an ACTION

3.10.4.1 This subject is introduced when CAPABILITY is described. It is continued here. The ability to specify a required CAPABILITY in order to complete an ACTION is necessary for planning optimal employment of resources and for managing resources during the life of an ACTION. ACTION-REQUIRED-CAPABILITY is defined as the specific CAPABILITYs required to satisfy an agreed operational need (an ACTION).

3.10.4.2 Use of this construct permits the matching of the available capabilities of battlespace objects or their types to the required capabilities in the selection of the most appropriate resources. Also, if the ACTION-REQUIRED-CAPABILITY is known, and, if a resource that was selected to match a CAPABILITY was suddenly not available or was no longer able to provide the requisite CAPABILITY, it alerts the planner that he should re-allocate replacement assets.

3.10.5 Role of an ORGANISATION with Respect to an ACTION

3.10.5.1 Specification Additional Roles. The addition of an associative entity between ACTION and ORGANISATION (ORGANISATION-ACTION-ASSOCIATION) permits the explicit specification of any role or roles that an ORGANISATION may have in relation to an ACTION over and above those covered by ACTION-OBJECTIVE or ACTION-RESOURCE. The roles could include initiation, co-ordination, planning, authorisation, oversight, distribution of orders and so on.

3.10.5.2 Specification Commander's Intent/Concept of Operations. The second, important function of the entity ORGANISATION-ACTION-ASSOCIATION is to enable the specification of commander's intent or concept of operations for an ACTION. Generally, this would be the top-level or mission task statement for a unit.

3.10.6 Guidance for Use of Resources

3.10.6.1 The structure consists of ACTION-RESOURCE-EMPLOYMENT and its subtype ACTION-AIRCRAFT-EMPLOYMENT. These entities enable the operational planner to provide additional guidance in the employment of resources either in relation to a specific objective or independently of it. Currently, the model features a single subtype for aircraft employment; however, the structure can be readily extended to provide guidance in other areas as operational information exchange requirements dictate. The structure is illustrated in Figure 23.

3.10.6.2 ACTION-RESOURCE-EMPLOYMENT is defined as the procedure for using a specific OBJECT-TYPE or OBJECT-ITEM against an objective in an ACTION. ACTION-RESOURCE-EMPLOYMENT is a dependent entity, derived from the relationship "is used according to/describes use of" from ACTION-RESOURCE. In addition, there is a non-identifying relationship "is the subject of/is relevant for" from ACTION-OBJECTIVE to ACTION-RESOURCE-EMPLOYMENT.

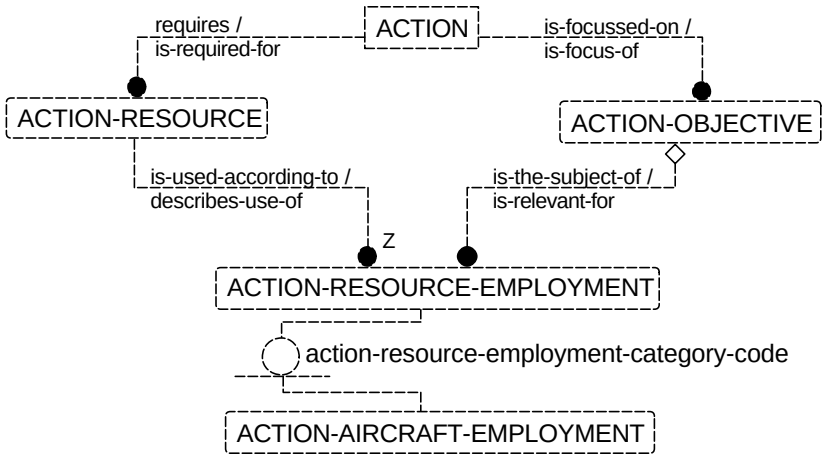

Figure 23. ACTION-RESOURCE-EMPLOYMENT

3.10.6.3 ACTION-AIRCRAFT-EMPLOYMENT is defined as the procedures which guide the utilisation of an ACTION-RESOURCE that is capable of atmospheric flight. The structure is currently used to specify some restrictions on aircraft employment that are intended to avoid harm to friendly troops and that also may be useful for deconflicting fires. The main data elements are: approach offset code, terminal attack direction angle, egress direction angle, deplanement method code, and inflight report requirement indicator code.

3.10.7 Rules of Engagement

3.10.7.1 An operational requirement is to be able to impose rules of engagement on operational activities. The functions include the imposition of a rule of engagement by an authorising agency, a request to be relieved from a rule of engagement and the consequent authorisation for relief if appropriate, and a request that a rule of engagement be imposed and the consequent authorisation for it if appropriate. The model incorporates for this purpose a structure consisting of three entities: RULE-OF-ENGAGEMENT, ACTION-TASK-RULE-OF-ENGAGEMENT and ORGANISATION-ACTION-TASK-RULE-OF-ENGAGEMENT-STATUS. The structure is illustrated in Figure 24.

3.10.7.2 RULE-OF-ENGAGEMENT is defined as a specification mandatory guidance for the way a given activity is to be executed. In essence, it provides a list of rules.

3.10.7.3 ACTION-TASK-RULE-OF-ENGAGEMENT is defined as the imposition of a specific RULE-OF-ENGAGEMENT on a specific ACTION-TASK. It permits the linking of specific rules to a specific ACTION-TASK.

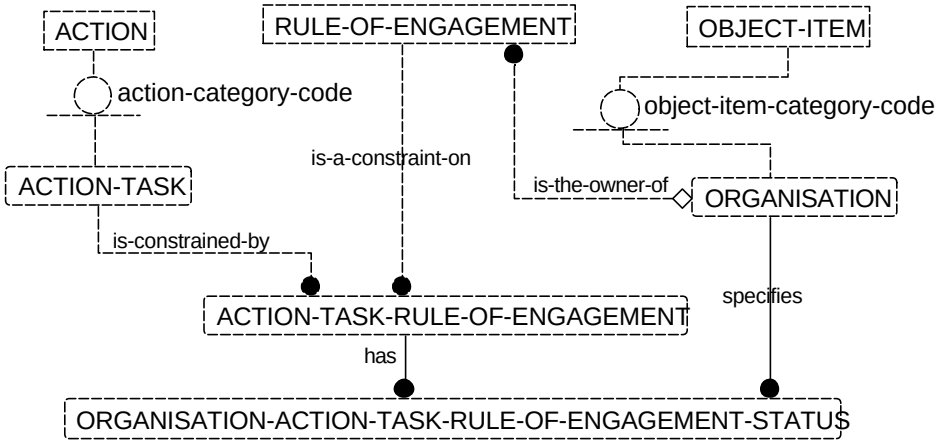

Figure 24. RULE-OF-ENGAGEMENT Structure

3.10.7.4 ORGANISATION-ACTION-TASK-RULE-OF-ENGAGEMENT-STATUS is defined as the status of the relationship between a specific ORGANISATION and a specific ACTION-TASK-RULE-OF-ENGAGEMENT with respect to a request for an application, a request for cancellation, or an authorisation.

3.10.8 Candidate Target Lists

3.10.8.1 The primary purpose of this structure is to enable the building of target lists for consideration during planning processes. The notion of a potential target is different from the notion of TARGET (a model entity) that is actually specified as an objective of activity in military planning. The structure permits the nomination of targets at any number of echelons with or without a change in target numbering. An item or type may be nominated as a target multiple times, possibly with a different activity focus in each nomination. The authorisation of candidate targets may also occur at multiple levels.

3.10.8.2 The structure for identifying potential targets includes two tiers of entities: the first to create candidate target lists and the second to itemise candidate targets individually. The model contains the entities CANDIDATE-TARGET-LIST and CANDIDATE-TARGET-DETAIL for this purpose. There is also a provision to specify authorisations for lists in their entirety and individual targets separately. The data structure consists of CANDIDATE-TARGET-LIST-AUTHORISATION and CANDIDATE-TARGET-DETAIL-AUTHORISATION. Since target lists are often likely to be related to each other, such as battalion and brigade-nominated lists with division lists, the model includes the CANDIDATE-TARGET-LIST-ASSOCIATION. A similar provision is made for relating individual targets, for example, the elements of a complex target such as a military airbase, a major logistics facility, or a naval port, through the entity CANDIDATE-TARGET-DETAIL-ASSOCIATION. The structure is illustrated in Figure 25.

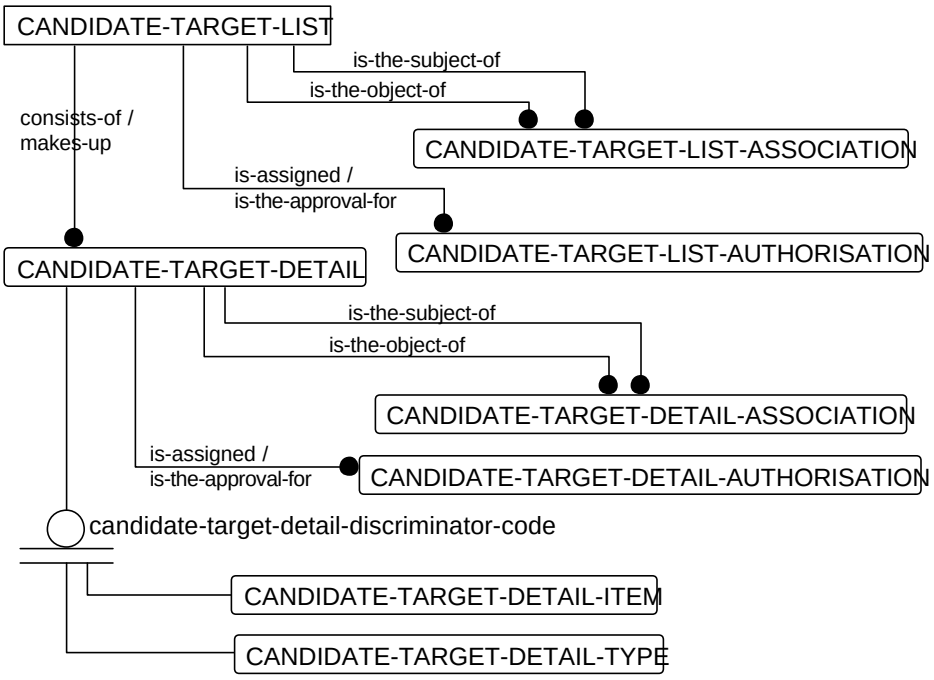

Figure 25. Candidate Target Structure

3.10.8.3 CANDIDATE-TARGET-LIST structure can be used to create prioritised lists of individually identified candidates. For example, Division A could nominate a specific enemy brigade for attack, a specific radar site for intercept activity, and a specific area in which friendly fire is to be avoided because a long-range reconnaissance patrol may be occupying it. The same structure can also be used to create targeting objectives by classes that may reflect the commander's intent: for example—in order of priority—command-and-control centres, armoured fighting vehicles, POL supplies, and fire-control radars in that order. Target lists can also be nested.

3.10.8.4 Nomination and authorisation of candidate targets is intended to be used in the operational planning process. The model structure that permits candidate target lists and individual candidate targets to be associated with the ACTION structure is illustrated in Figure 26. The primary connection is from CANDIDATE-TARGET-LIST to ACTION-TASK.

3.10.8.5 A connection also exists for individual candidate targets through the relationships "may be specified as" from CANDIDATE-TARGET-DETAIL-ITEM and CANDIDATE-TARGET-DETAIL-TYPE to ACTION-OBJECTIVE-ITEM and ACTION-OBJECTIVE-TYPE. These relationships permit an explicit association between a target nomination and the designation of any item or type as a planned objective of a specific ACTION.

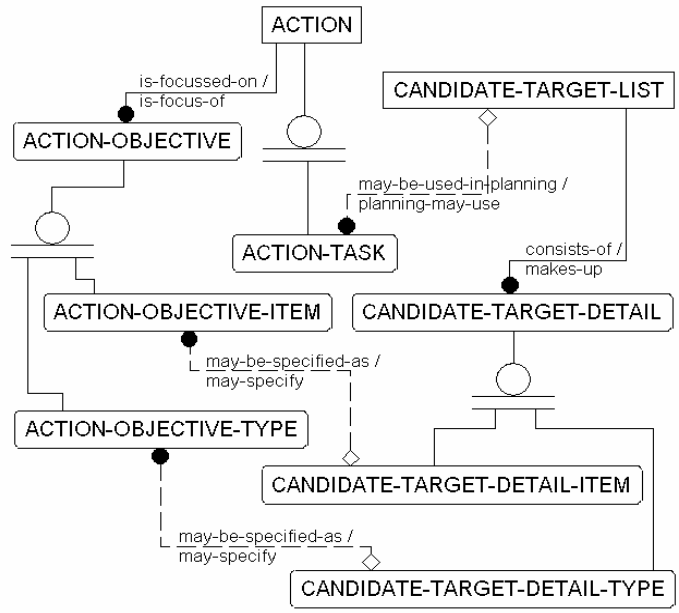

Figure 26. Linking Candidate Targets to Operations Planning

3.10.9 Context for an ACTION

3.10.9.1 CONTEXT structure enables the specification of related data of the type that is referred to as an operational overlay. The planner can use the CONTEXT information to judge the merits of a plan or an order, and to assess a need for changes. Details of CONTEXT usage are presented in the next section.

3.10.9.2 ACTION-CONTEXT links ACTION to CONTEXT. In general, CONTEXT helps to set the whole situation, background, or environment relevant to a particular ACTION. It can specify conditions that must precede an ACTION or those that should result from the execution of an ACTION. It can also add constraints on ACTIONs.

3.11 Data about Reported Data

3.11.1 Introduction

3.11.1.1 Considerable amount of information about battlespace situation consists of reports by persons or organisations. These generally refer to dynamic data, such as location, status, holdings, associations, and classification, regardless of whether the information refers to friendly, neutral, or hostile elements. It is also important to know for each report the source, the effective date and time for the estimate, the duration for which the estimate is valid, the reporting date and time, and the degree of validity of the estimate. The model can capture both types of information: the substantive information in numerous entities and the reporting information in REPORTING-DATA and its subtypes.

3.11.1.2 Amplifying information enables a staff officer to compare different reports and make a sensible interpretation of the data. It also allows the staff officer to enter his own perception of reality based upon the raw data; this may be particularly

applicable to an intelligence function that produces correlated information at a higher quality level.

3.11.1.3 REPORTING-DATA permits a mechanism for maintaining a historical record that applies not only to the past and present, but also to the future. Thus, it is just as easy to record that the *required* stockage level of an ammunition stock should be 10,000 three days from now as it is to record that the *reported* stockage level yesterday was 8,200.

3.11.1.4 REPORTING-DATA is linked to many entities through a non-identifying relationship "provides applicable information for." Most relationships require that a record in REPORTING-DATA be created for every new set of dynamic information. The reasons are twofold. If information is provided without an indication of the source, the validity, and the applicable times, it raises questions as to the source (Who says so?), the quality (Is this information verified?), and timing (When did it happen and when was this reported?). A secondary reason is to provide a capability to refer to each item of dynamic information when that information is required to create a broader context for information—a topic discussed in Section 3.12.

3.11.2 REPORTING-DATA Structure

3.11.2.1 REPORTING-DATA is defined as the specification of source, quality and timing that applies to reported data. Its structure is illustrated in Figure 27. It has a mandatory relationship to ORGANISATION that is the reporting agent. It has an optional relationship to REFERENCE. Its two subtypes serve to specify timing information.

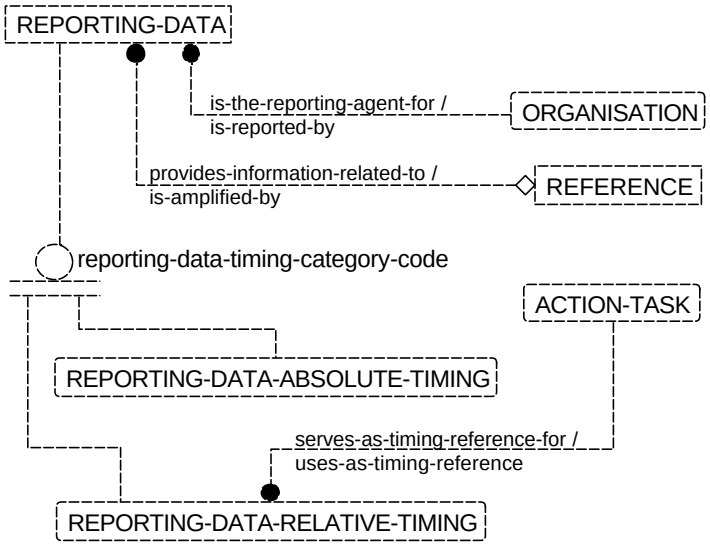

Figure 27. Structure for REPORTING-DATA

3.11.2.2 Ability to cite sources of information that are external to the data structures is useful. The sources could be ADatP-3 messages, printouts of electronic mail, memoranda of telephone conversations, and other physical storage means that need to be consulted. REFERENCE provides this functionality. REFERENCE pointers can be

associated with one or more instances of REPORTING-DATA in order to amplify the data that is referred to by REPORTING-DATA.

3.11.3 Specifying Time

3.11.3.1 Time[10] points and time periods having a specific military significance need to be specified; for example, the starting time of an action, the reporting time of a situation report, and the period of time covered by a weather forecast. There is also a need to specify time as fixed or relative:

a. Fixed (*absolute*) with respect to the standard calendar (e.g., 120700Z Sep69)

b. *Relative* with respect to an arbitrary origin that may be unspecified (e.g., D+3).

Absolute and relative time characteristics are captured in subtypes REPORTING-DATA-ABSOLUTE-TIMING and REPORTING-DATA-RELATIVE-TIMING.

3.11.3.2 REPORTING-DATA-ABSOLUTE-TIMING is defined as a REPORTING-DATA that specifies effective date and time that are referenced to Universal Time. The specified epoch can be in the past, the present, or the future. The date follows the Gregorian calendar and the 24-hour clock time is defined with respect to Universal Time.

3.11.3.3 Effective time can also be relative. REPORTING-DATA-RELATIVE-TIMING is defined as a REPORTING-DATA that specifies effective timing that is referenced to a specific ACTION-TASK. Relative timing makes operational sense only in relation to planned activities; consequently, the origin of the time scale is established in relation to an instance of ACTION-TASK.

3.12 CONTEXT Structure

13.12.1 Introduction

13.12.1.1 CONTEXT provides a mechanism for pointing to one or more records in numerous tables and treating them as a single group or package of data that can stand alone as part of situational awareness or be linked to instances of ACTION, OBJECT-ITEM or REPORTING-DATA. It depends on multiple connectivity that REPORTING-DATA has to other entities in the model.

13.12.1.2 CONTEXT can be used to group data without creating new information, such as a collection of data that is relevant to the situation, background, or environment for a particular ACTION. It can specify conditions that must precede an ACTION or those that should result from the execution of an ACTION. Planners can use the context information to judge the merits of a plan or order, and make changes in plans in order to respond to a changing battlespace situation. Commanders can use the context information to choose between multiple courses of action. The construct can also be used to re-capture a situation as it existed at some time in the past or is expected to exist at a future date.

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[10] The word “time” when used in the context of natural language refers to the general notion of time that encompasses collectively the specific meanings of the class words “date” and “time.”

13.12.1.3 Grouping of data by means of CONTEXT can also help to manage dynamic information by helping to prevent inadvertent loss of significant information that may not be recognised as such if it is not linked to a situational description.

3.12.2 CONTEXT Structure

The CONTEXT structure is shown in Figure 28. Basically, it can collect any number of pointers to instances of REPORTING-DATA through CONTEXT-ELEMENT.

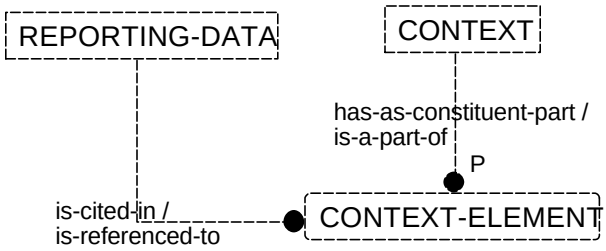


Figure 28. Building CONTEXT

3.12.3 Overview of CONTEXT Functionality

3.12.3.1 CONTEXT structure serves several different functions through relationships to other entities. These are shown in Figure 29 at the entity level. Each of the individual functions is marked with a "Function x" block in the diagram as a reference for discussion.

3.12.3.2 *Function 1* relates an instance of CONTEXT to an instance of OBJECT-ITEM. This is a potentially powerful tool that has not been exploited in past applications of the model.

3.12.3.3 *Function 2* refers to the potential for adding a limited amount of free text to any context. Addition of text in CONTEXT-ASSESSMENT is optional, but if an assessment is added it becomes an integral part of "context."

3.12.3.4 *Function 3* permits creation of new data to be linked to an existing "context." One of its uses is to record the results of data correlation or data fusion. An intelligence analyst may create an intelligence appreciation about the location of an enemy unit by basing it on a number of different observations. The analyst then creates an entry in OBJECT-ITEM-LOCATION with an associated entry in REPORTING-DATA that points through CONTEXT to all the data being used. For example, an analyst's Reporting Data 4 may be associated with previous Reporting Data 1, Reporting Data 2, and Reporting Data 3. The new estimate itself needs to be described by a suitable REPORTING-DATA. This is done through CONTEXT-REPORTING-DATA-ASSOCIATION that relates a specific CONTEXT as a subject with another REPORTING-DATA as an object. The relationship is characterised by the following values: Implies, Is confirmed by, Is corrected by, Is defined to be, Is negated by, Is superseded by.

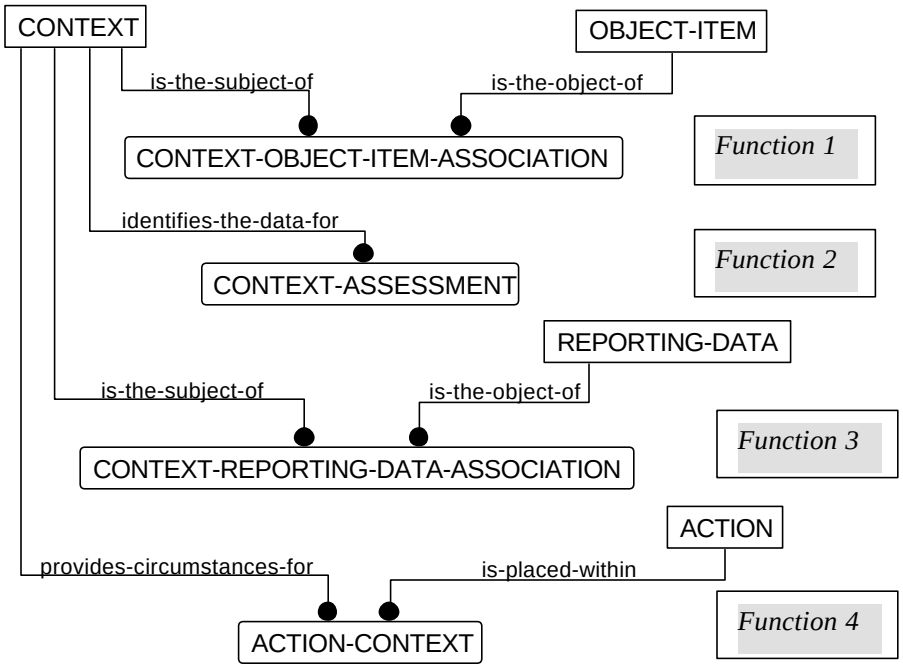


Figure 29. CONTEXT Functionality

3.12.3.5 *Function 4* relates an instance of CONTEXT to an instance of ACTION. This is an important linkage that permits a considerable amount of information to be coupled to plans and orders.

3.13 Summary of LC2IEDM Features

3.13.1 An overview of the data model is presented in Figure 30. The nine main entities are shaded in grey. The grouping of entities is instructive in itself. The bottom part of the diagram centred about OBJECT-TYPE, OBJECT-ITEM, and LOCATION portrays the contents of the battlespace: what is out there, what does it have, what is it supposed to have, where is it, what is its status, what are its relationships with other objects in the battlespace.

3.13.2 Upper part is focused on ACTION with CAPABILITY, CONTEXT, and RULE-OF-ENGAGEMENT being oriented primarily to ACTION. Much of this data tends to be dynamic in nature: what are the objects capable of and how are they to be used, how are they being used, and what are they achieving.

3.13.3 REPORTING-DATA plays a special role in the model. It records reporting data about much of the information held in the lower part of the model. It also serves as the means for that information to be used in multiple ways in developing courses of action, allocating resources, preparing plans, and executing operations orders, all of which are in the province of the upper part of the model.

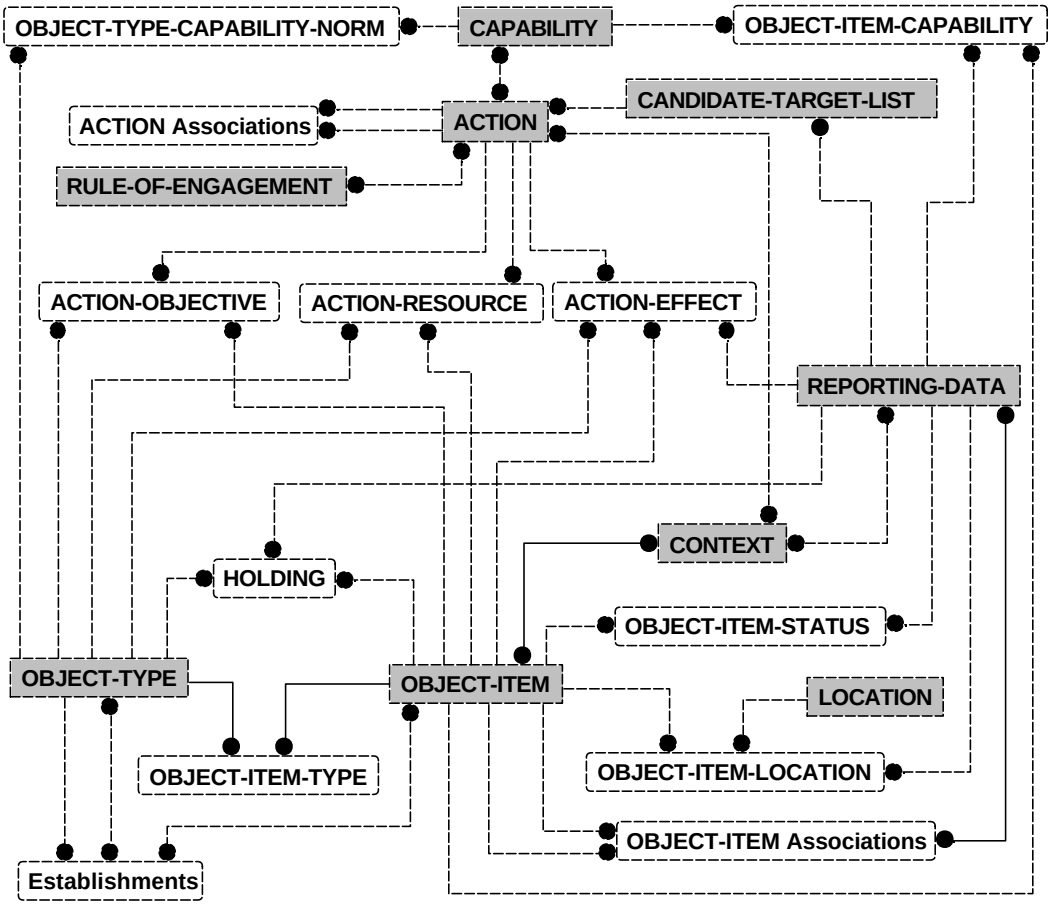


Figure 30. High-Level View of LC2IEDM

3.13.4 The upper and the lower parts are connected through a number of associative entities that are used for linking plans, orders, and requests through objectives, resources, and effects to OBJECT-TYPEs and OBJECT-ITEMs.

3.13.5 An example to illustrate the use of the data structures follows.

3.14 Examples of Potential Use

3.14.1 Producing Plans

The model supports the planning process by capturing information at each stage, and permitting a variety of planning options to be examined. The steps in planning may include the following:

a. Create a new ACTION-TASK or specify new parameters for an existing ACTION in order to take the initiative or to respond to an ACTION-EVENT.

b. Add detail to the ACTION-TASK by using the functional and temporal associations. This permits the subdivision of the plan into sub-activities with differing functional and temporal relationships to the high-level plan.

c. Identify the ACTION-OBJECTIVEs in terms of OBJECT-TYPEs and/or OBJECT-ITEMs. This is the mechanism for identifying key objectives in terms of enemy units, facilities, and materiel (e.g., destroy a bridge in enemy held territory).

d. Search for the required CAPABILITYs to perform the ACTION. This is the process of matching the appropriate ACTION-RESOURCE to meet the requirements of a specific ACTION. For example, crossing of an obstacle requires the employment of an engineer UNIT-TYPE with the appropriate CAPABILITY, and the movement of personnel requires vehicles or aircraft with the appropriate payloads.

e. Allocate OBJECT-TYPE as an ACTION-RESOURCE to a ACTION-TASK based on its CAPABILITY-NORM. Having identified the requirement for troop-carrying vehicles, this step requires the allocation of, for example, 12 Blackhawk helicopters.

f. In order to determine what resources are available for this ACTION, search for OBJECT-ITEMs whose OBJECT-ITEM-CAPABILITY matches the CAPABILITY-NORM for their type. For example, the 3rd US Aviation Brigade may have 24 Blackhawk helicopters and the 1st US Marine Expeditionary Force may have 12.

g. Allocate individual OBJECT-ITEMs as ACTION-RESOURCEs to an ACTION-TASK. Twelve Blackhawk helicopters from the 3rd US Aviation Brigade are designated to perform the task.

h. Define CONTROL-FEATUREs to support the ACTION. Such features may be air corridors, low-level transit routes, or target areas.

3.14.2 Generating Orders

Once the planning process is complete, an order can be generated by simply converting the status of a particular plan, or a series of plans, from “plan” to “order.”

3.14.3 Reporting of Status

Status reporting deals with a wide range of objects, from an individual soldier to a complete situation report. The entities used to generate such reports encompass most of the data model. The following is a sample of possible applications:

a. The OBJECT-ITEM-STATUS entity can be used to record information about individual OBJECT-ITEMs (e.g., Sgt. T. Hanks is wounded in action; 15 (GE) Panzer Division is fully operational).

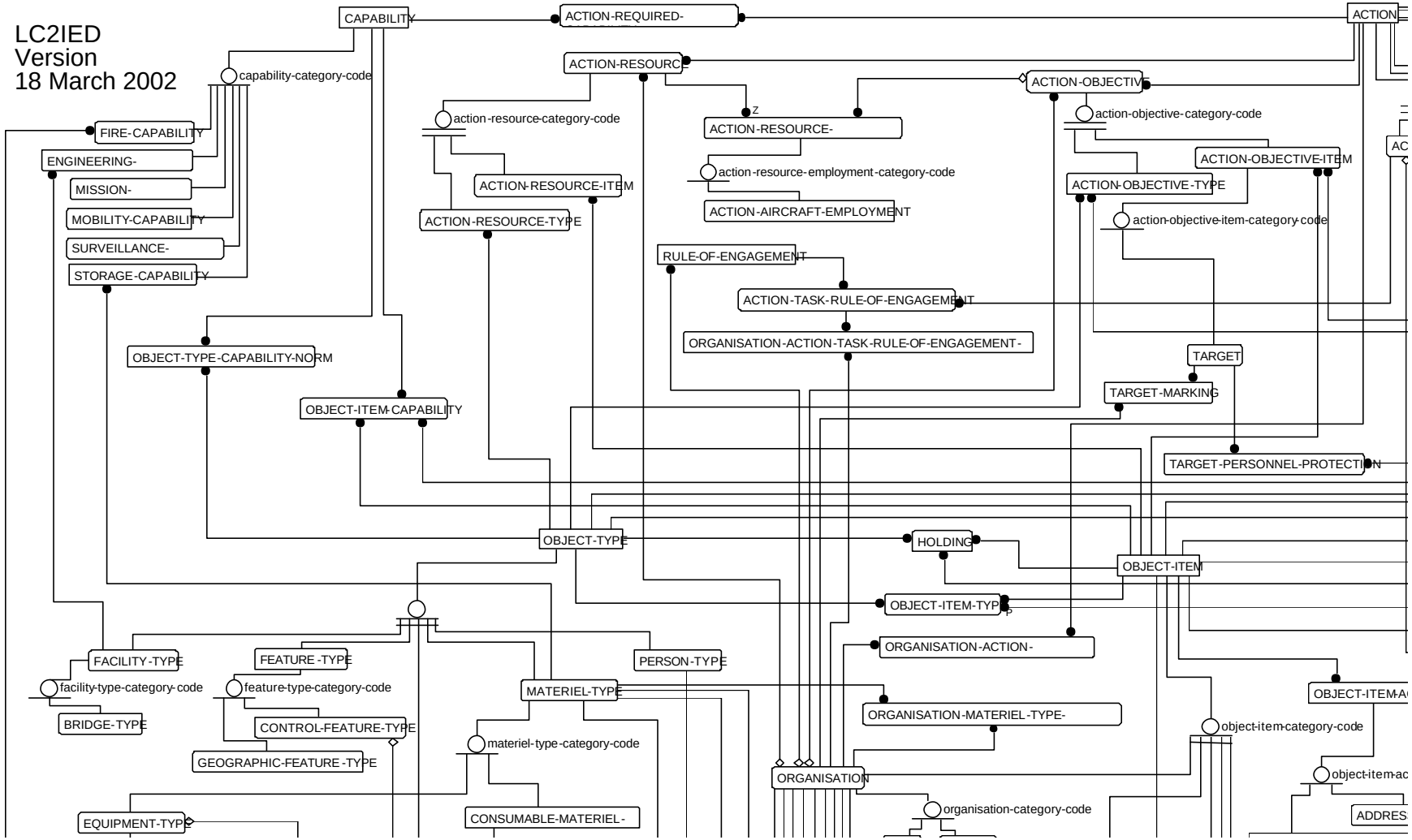
b. ACTION-TASK-STATUS may be used to provide updates on the dynamics of the battlespace (e.g., minefield laying 70 percent complete, estimated time of completion + 2 hours).

c. ACTION-EVENT-STATUS provides a means of reporting unplanned activity (e.g., flooding started at 1626 on 18 July 2000).

d. OBJECT-ITEM associations can be used to specify a friendly/enemy order of battle (in particular, ORGANISATION-ORGANISATION-ASSOCIATION).

e. Establishments and HOLDING can be used to indicate surpluses or deficiencies (e.g., 1 (DA) Mechanised Brigade has a holding of 50 Leopard I main battle tanks whereas it is established to have 56).

Annex A Entity Level View of LC2IEDM


LC2IED
Version
18 March 2002
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FIRE-CAPABILITY
ENGINEERING-
MISSION-
MOBILITY-CAPABILITY
SURVEILLANCE-
STORAGE-CAPABILITY
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ACTION-OBJECTIVE-ITEM
ACTION-OBJECTIVE-TYPE
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ACTION-TASK-RULE-OF-ENGAGEMENT
ORGANISATION-ACTION-TASK-RULE-OF-ENGAGEMENT-
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TARGET-MARKING
OBJECT-ITEM-CAPABILITY
TARGET-PERSONNEL-PROTECTION
OBJECT-TYPE
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OBJECT-ITEM
OBJECT-ITEM-TYPE
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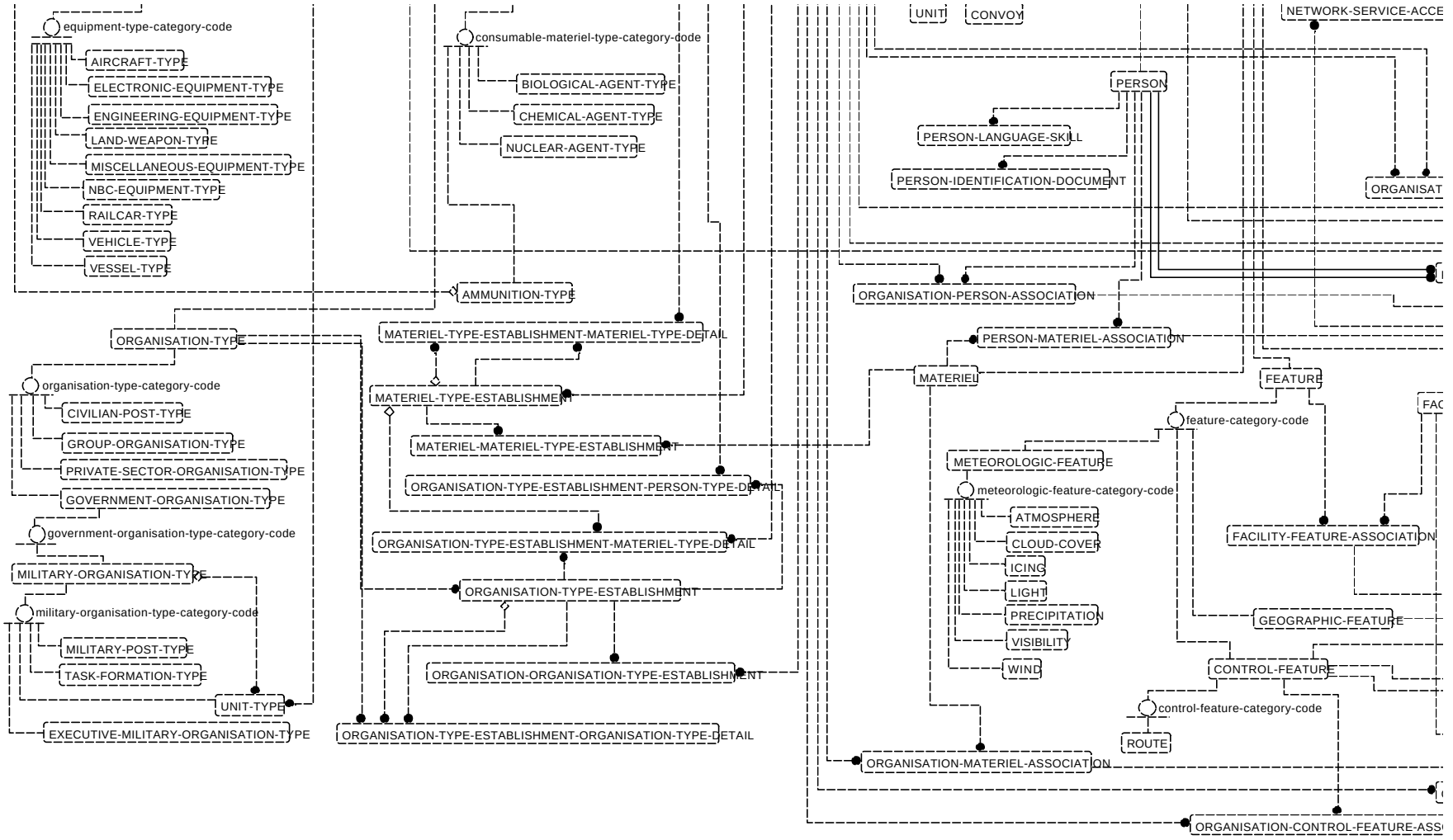
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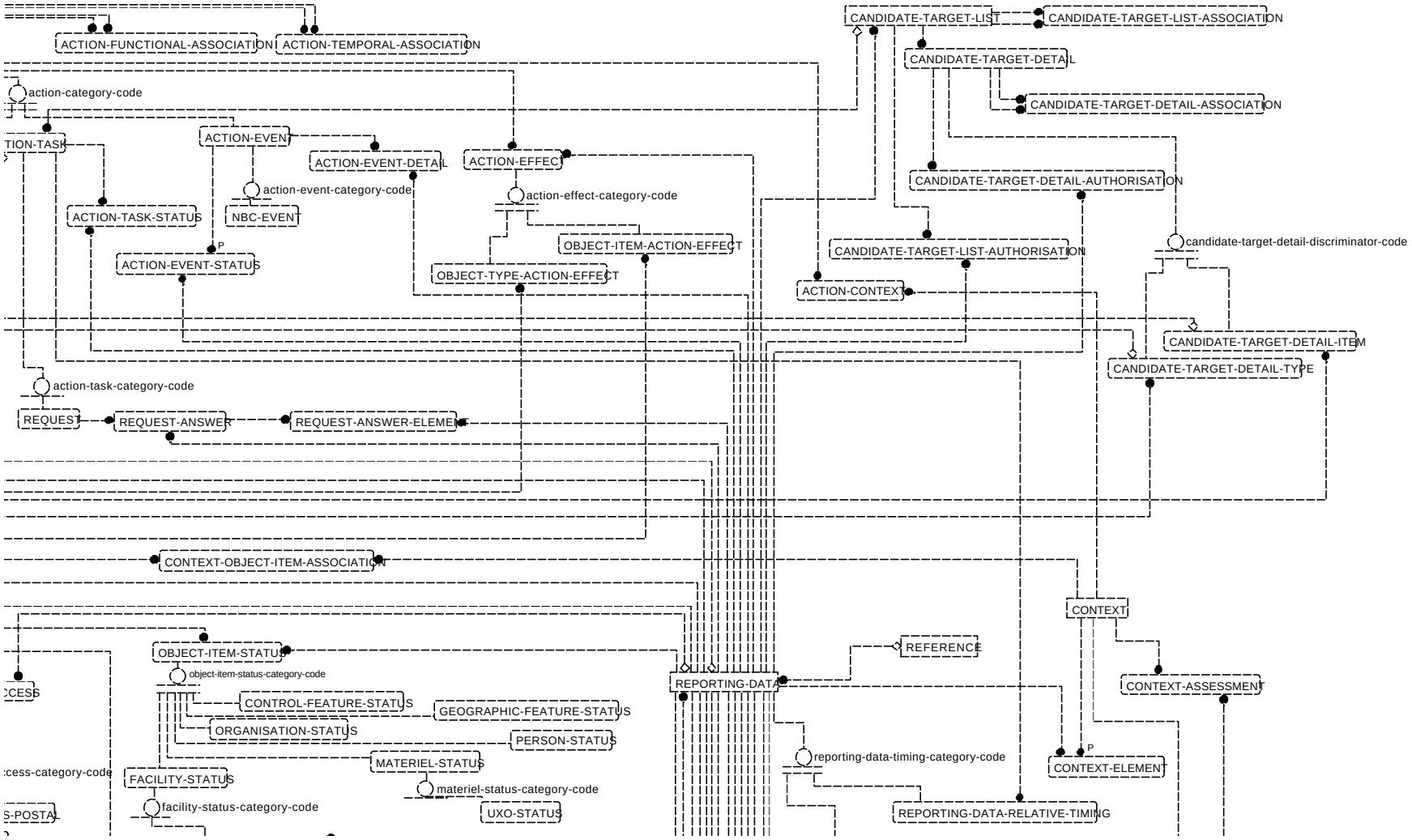
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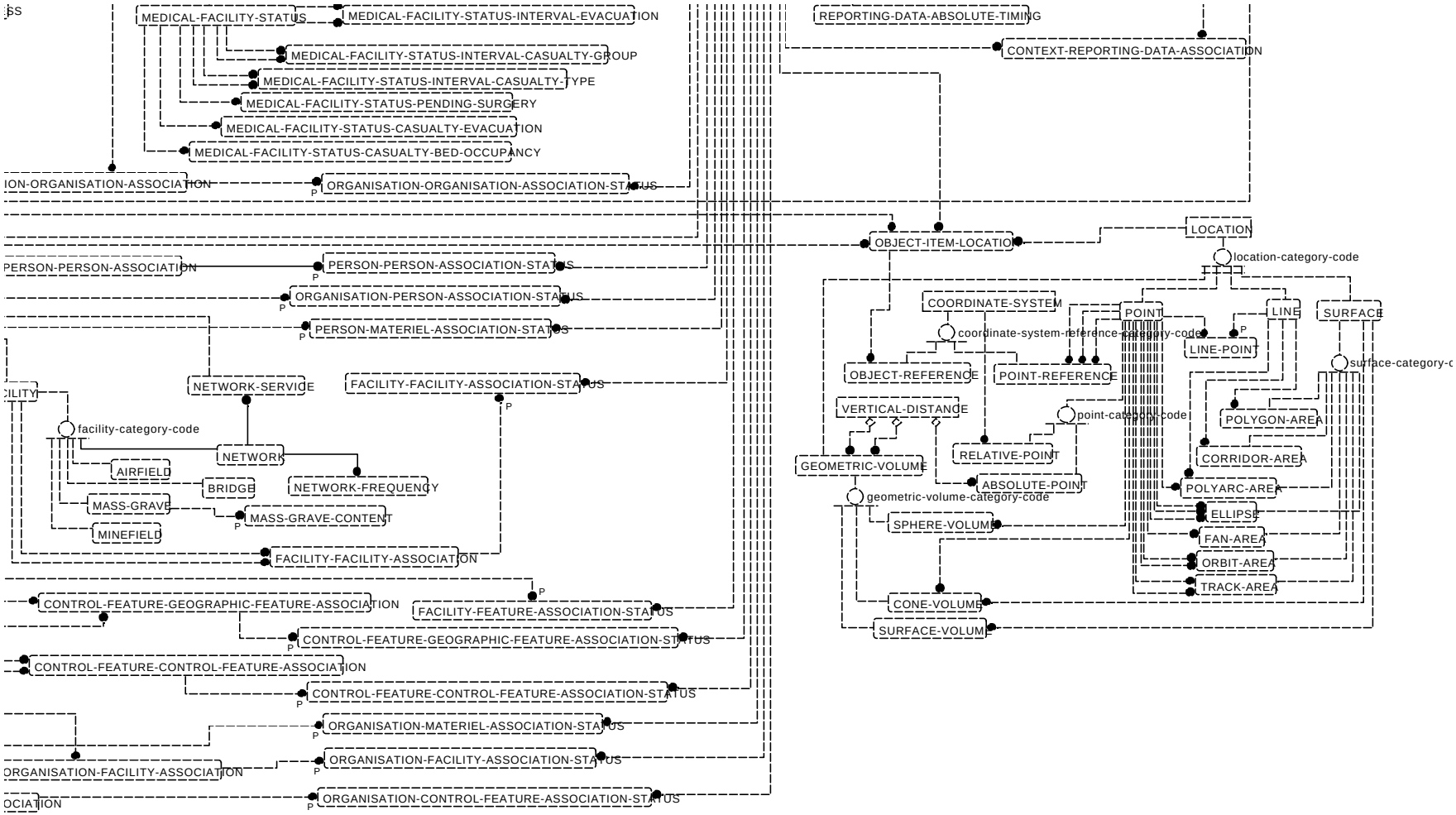
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SURFACE-VOLUM

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